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TURNIP AND RAPE SEED PRODUCTION IN NEW ZEALAND.

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THE possibility of producing in New Zealand our requirements of turnip, swede, rape, and kale seed forms the subject of this article, and will be dealt with in two parts. In the first will be discussed the importance of the turnip and rape seed trade to New Zealand, the advantage to be gained by growing our own requirements, and certain limiting factors in the production of these seeds. The second part, which it is intended to print in the next issue of the *Journal*, will deal with the methods of seed production, and the precautions that have to be observed in maintaining quality.

PART I.—TRADE ESTABLISHMENT ASPECTS.

IMPORTANCE OF THE TRADE.

Table 1 shows the quantities and values of imports of swede and turnip seed, together with the area sown in New Zealand from 1927 to 1931. The value shown is the current domestic value in the country of export at the time of exportation, plus 10 per cent.

Table 1.—Turnip and Swede Seed imported into New Zealand(1).

Source.	1927.		1928.		1929.		1930.		1931.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£
United Kingdom	4,748	33,864	5,039	28,546	5,709	32,898	4,069	43,187	4,002	20,847
Denmark ..	..	..	6	15	5	11	25	208	45	118
France	..	..	..	..	..	..	..	..	12	31
Netherlands ..	3	11	..	..	..	..	..	..	..	..
Total ..	4,751	33,875	5,045	28,561	5,714	32,909	4,094	43,395	4,059	20,996
Acreage sown in New Zealand for feeding*	1927–28. 459,704		1928–29. 479,994		1929–30. 475,254		1930–31. 441,214		1931–32. 432,229	

* About 50,000 acres of mixed turnips and rape are grown annually and are not included in these figures.

It will be seen that between 1927 and 1930 the average annual imports have been about 245 tons, valued at approximately £34,685. This is equivalent to a fraction over 1s. 3d. per pound. The season 1931–32 was in many respects unusual, and the figures reflect the first serious effects of the depression. In this season there has been a substantial decrease in imports, and an equally pronounced drop in value from 1s. 3d. to below 1s. per pound. The imports during the first six months of 1932 are not included. They represent only a fraction of the total, since most of the seed arrives in the spring; nevertheless those shipments that had arrived showed a further substantial drop in values.

Table 2 records the value and imports of rape and kale seed. Again the value shown is the current domestic value in the country of export at the time of exportation, plus 10 per cent.

Table 2.—Rape and Kale Seed imported into New Zealand[1].

Source.	1927.		1928.		1929.		1930.		1931.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£
United Kingdom	3,048	7,886	3,068	7,170	3,704	10,973	3,716	12,152	3,420	8,246
Denmark ..	200	616	..	..	..	..	..	..	..	..
France	..	..	..	..	98	174	..	..	..	..
Netherlands ..	189	302	494	679	185	301	800	1,035	746	640
Japan	..	..	..	..	600	766	900	1,130	401	309
Total ..	3,437	8,804	3,562	7,849	4,587	12,214	5,416	14,317	4,567	9,255
Acreage sown in New Zealand for feeding*	1927–28. 196,000		1928–29. 198,000		1929–30. 184,000		1930–31. 168,000		Not available.	

* About 50,000 acres of mixed turnips and rape are grown annually and are not included in these figures.

This table shows that between 1927 and 1930 the average annual importations have been 212·5 tons, valued at £10,796, or 5½d. per pound. In 1931 there has not been any decline in imports, but a decline in values to 4½d. per pound has taken place. Imports for 1932 are not shown in the table, but for the first six months, during which only a small proportion of New Zealand's requirements were imported, the values from the United Kingdom were maintained at 7·2d., while those from the Netherlands fell as low as 2·4d. These prices cover only about 25 tons, and cannot therefore be considered representative of the new season's values.

The total seed produced within New Zealand amounts to very little. The Government Statistician gives the quantity harvested in 1930–31 as 4,000 lb. of rape and 3,900 lb. of kale. This represents about the average for New Zealand during the few preceding years. During the same period little or no turnip seed was harvested, but in 1930–31 seed-growing was commenced on a fairly large scale by one grower.

Reviewing the position, one may regard the seed of rape, kale, turnips, and swedes used in New Zealand to be worth from £45,000 to £50,000 per annum. This compares favourably with the value of some

of the less important farm seeds grown in the Dominion, for which the average of the four seasons 1927–28 to 1930–31 was as follows: Cocksfoot, £68,345; red clover, £42,823; linseed, £39,541; white clover, £21,057; beans, £1,578. Obviously, then, it would be worth while to consider seriously the possibility of developing within New Zealand an industry that will compare so well with these standard products.

Advantages to be gained by growing our own Requirements.

However one may view at this stage the possibility of economic production, certain very definite advantages are to be gained by growing our own requirements apart from those already discussed. These may be summarized as follows:—

(1) While one must admit that very rarely is seed of distinctly poor germination offered to the farmer, yet the general experience is that locally produced seed germinates with greater vigour. The seedlings are more robust, resulting in a better stand, and the practical grower will readily appreciate the importance of having the plants through the ground with the least possible delay.

(2) The strategic position of New Zealand in time of war or industrial strife is worthy of consideration. Not only may we be forced to use seed of inferior quality, but there is also a real danger of shortage.

During the war of 1914–18 Great Britain prohibited the export of turnip and swede seed except under licenses granted by her authorities. Retail prices soared, and in 1918 the position became serious enough to threaten our pastoral industry. Farmers were advised to undertake increased sowings of autumn forage crops such as Western Wolths ryegrass, and to avoid bare stubble by the inclusion of clovers and temporary grasses along with the grain crop([4]).

Having sources other than the European countries from which to draw supplies, the position in regard to rape seed was not so critical. Nevertheless, importers had to be warned at that time of the care needed in purchasing rape seed from Japan, a country which produced also large quantities of colza or oil rape, an annual of no value for forage purposes([7]).

Were we in New Zealand to produce even part of our requirements, we would have a nucleus around which to expand, and not be in the difficult position of 1918 when we were forced into production without adequate knowledge or experience.

(3) Disease in cruciferous crops is a serious factor. Dry-rot, in particular, ruins the keeping-quality of the roots, and these have to be fed off early to avoid waste, whereas they should serve as a holding crop over the winter. Were it not for this one disease, a much greater acreage would be sown annually to swedes.

Research undertaken by workers in the Mycological Section of the Plant Research Station([5]) has proved dry-rot to be seed-borne. They have demonstrated seed treatment to be effective to the extent of ensuring that seed may be rendered disease-free, and, providing outside infection is avoided, that the sowing of such seed will ensure the production of a clean crop. Disease control in the countries from which we draw our supplies would be hardly possible, but some control over

seed produced in New Zealand under a combination of seed treatment and seed certification is by no means impossible.

Club-root is equally serious, and in this connection the Mycological Section and the Fields Division at the Gore Experimental Area are investigating strains of turnips, swedes, and rape which are resistant to this disease. It seems obvious that if this work is to bear fruit we must be in a position to raise our own seed. To do this in sufficient quantities necessitates the organization of seed production in New Zealand.

(4) There may not be a multiplicity of varieties of turnips and swedes, but there is certainly a multiplicity of names. Many varietal names are obviously synonyms. There is in fact a deplorable lack of understanding in regard to varietal names, and, apart from this, probably far fewer varieties would serve our purpose in New Zealand. A simplification of the position in regard to nomenclature would be welcomed alike by seed merchant and grower.

Recent investigation([6]) has demonstrated that three types of rape are imported into New Zealand. Morphologically they are quite distinct, yet the varietal name under which they are sold is no indication as to type. Each, no doubt, has its sphere of economic adaptation, and hence it should be possible to purchase the desired type, a condition we can scarcely hope to attain unless we grow our own seed in New Zealand.

(5) Finally, there is the important question of varieties adapting themselves or being adapted to the conditions under which they are to be grown. Referring to agricultural seeds generally, we know that in certain districts certain varieties will grow well, and that in other districts these same varieties will fail. Turnip and swede varieties are extremely selective, and require specific conditions for their best development. For example, many varieties which fail at the Plant Research Station give excellent crops at the Gore Experimental Area in Southland.

Were we to raise our own seed in New Zealand, under a process of selection similar to that adopted in other countries, there is every reason to expect that we would, at the same time, isolate those strains best adapted to our particular conditions. The strains of rape, kale, swede, and turnip we are growing now are those which have proved themselves in some other part of the world under conditions not necessarily similar to the conditions they will experience in New Zealand. The case of other farm seeds may not be altogether analogous, but we would fail were we to grow varieties in this country merely because they are in favour overseas. Solid Straw Tuscan wheat, for example, has captured New Zealand solely because of its better adaptation than other varieties, however well these latter may have proved themselves elsewhere, as in England or Canada. When we consider these matters it seems likely that marked improvement would be effected by selecting and growing our requirements in our own country.

Limiting Factors.

The production of seed is not attended with serious technical difficulties, and the precautions that have to be taken are discussed in the

second part of this article. On the other hand, the commercial establishment and regulation of seed production in this country will meet with certain difficulties, some of which will now be discussed.

(1) ECONOMIC POSSIBILITIES.

This question is raised first, because no amount of reasoning will persuade the farmer and merchant into growing these seeds unless he can at the same time be given a reasonable hope that the venture will be at least as profitable as other lines of production.

Yields.—In Essex (England) the average yield of swede and turnip seed is about 7 cwt. per acre(2). The yields from most of the successful New Zealand crops of which we have any record have varied from 3 cwt. to 8 cwt., with an average of about 5 cwt. per acre. Rape may be expected to yield more heavily, and a reasonably good crop should thresh out 7 cwt. to 10 cwt. of seed per acre.

Prices.—Perhaps no more difficult period in our history than that through which we are passing could have been chosen in which to make estimates of values. Wide fluctuations in seed prices during the past two years render it extremely difficult to arrive at a figure upon which to base estimates. Between 1927 and 1930 the domestic value of turnip and swede seed in the country of export varied a little around 1s. 3d. per pound. In 1931 the value had fallen below 1s., and we may expect a further substantial fall in 1932. Rape seed which had been maintained at a little below 6d. per pound had also fallen in 1931 to 4½d.

It would be unreasonable to take as a price basis the figures of 1931 to 1932. They represent what we may hope is the full and final effect of the depression, and at such prices seed-growing must be as unprofitable as other lines of production have proved to be during the same period. We may presume that merchants in this country would be willing to pay local growers—at least during the initial stages of development—a price equivalent to that which they have to pay in the exporting countries, and a figure round about 1s. to 1s. 2d. per pound for swede and turnip seed does not seem unreasonable in more normal times. This price is, however, from two to three times as much as that paid to contract growers in England, and we would have to produce at a figure considerably below this before we could hope to develop an export trade in competition with Continental seed. A yield of 5 cwt. per acre at 1s. per pound will give a gross return of £28 per acre.

Costs.—In Essex, prior to the war(2), land-values for seed production averaged about £40 per acre, and rentals from 25s. to 30s. per annum. Yields ranged about 7 cwt. per acre and prices about 4d. per pound.

Ward(3) in 1922 estimated the cost of production in New Zealand as follows, using as his basis three years' experience of turnip seed growing by Mr. Norman Campbell, of Geraldine: Rent, £2; ploughing once, 10s. 6d.; three cultivations, 10s.; three harrowings, 4s. 6d.; drilling, 2s. 6d.; seed and manure, £1 8s. 9d.; twine and binder cutting, 12s.; threshing, £2 2s.; seed dressing, 8s. 4d.; overhead, £2: total, £9 18s. 7d. With a yield of 400 lb. of seed per acre at 1s. 3d. per pound = £25, a credit balance is shown of £15 1s. 5d. per acre. In this case land was valued at £20 per acre, and the rental of £2 covered two years.

In practice the cost of producing the roots will be no greater than that involved in the production of a crop for stock-feed, although a certain amount of intertillage may be necessary. Harvesting, if performed by hand, will be found an expensive item. The most practical and economical method is the use of a side-delivery mower. This is capable of keeping six men busy tying the sheaves loosely with binder twine. The use of the reaper and binder, although more expeditious, will certainly result in a serious loss of seed. It is usual to allow the sheaves to dry in the field without stooking. Threshing offers no difficulty. The sheaves should be stacked for three months, and may be put through an ordinary mill, attempting to thresh as lightly as possible. The pods are extremely brittle, and hand flailing, although tedious, is not unduly expensive on small areas and avoids any damage to the seed.

The crop occupies the ground for about twelve months. Sown in December or January, the seed crop will be harvested by the following January and the land available in ample time for autumn sowing. Considering, however, the desirability of an extended fallow prior to sowing, a charge of practically two years' rent is warranted.

Wheat is our most important grain crop, and one with which we might justifiably compare other seed and grain crops. Wheat-growing, however, is a protected industry, and it is difficult to say just what price the farmer would receive at the present time were this protection removed. On the other hand, this protection aims at making wheat-growing sufficiently profitable to maintain the industry; therefore any other line of production which can give as good a return as wheat-growing should result in adequate remuneration to the grower. An authoritative statement places the average gross return for wheat-growing at £6 10s. per acre. Allowing £7 per acre we would have a gross return over two seasons of £14 per acre.

The return from turnip seed growing would depend on price and yield. A yield of 5 cwt. per acre and a price of 1s. per pound would give a gross return of £28, which is double that of wheat. Were the price of seed reduced to as low as 6d. per pound the gross return would be no less than for wheat. We have then a considerable margin for fluctuation in price and yield before the gross return from seed production would fall as low as that from wheat. In addition we have also to consider that autumn-sown wheat occupies the ground for about nine months each year, or eighteen months over two years. Excluding the fallow, one crop of turnip seed will occupy the land for only twelve months.

In the production of two crops of wheat we have all expenses doubled. Land preparation, sowing and manuring, harvesting and threshing are undertaken twice. In the case of a biennial seed-crop like swedes and turnips, these operations are undertaken only once. Possibly the cost of harvesting root seeds may be as much as twice that of wheat; nevertheless, taking everything into account, the cost of producing one seed crop must be considerably below the cost of producing two wheat crops.

Finally, there is reason to expect that the growing of turnip seed (but not of swede seed) will prove to be well adapted to our lighter lands. Here late sowing of turnips is becoming increasingly popular.

The benefit lies in catching the autumn rains about March, and avoiding the dry months of January and February. Sowing for seed production would undoubtedly follow this lead and be undertaken in February-March. Seed would be harvested the following December-January, and the crop would not have to pass through what is generally the most critical period of the year on these light lands. Per-acre yields would, of course, be small, but, on the other hand, rent and cultural operations would be proportionately low.

Summarizing the position, we may conclude that turnip seed growing offers satisfactory remuneration on arable farms in the seed-growing districts of New Zealand, and compares more than favourably with the return obtained from other field crops.

The production of rape seed offers still better prospects. The lower price is offset to some extent by a higher yield, but more important still is the fact that the crop may be used for a dual purpose. Provided the rape crop is not grazed too severely, the stalks may be allowed to overwinter in the ground and a seed crop produced in the following spring. There seems no reason why we should send abroad each year for £10,000 worth of rape seed which could be produced quite well within the Dominion.

(2) COUNTER INTERESTS.

New Zealand merchants have for many years regularly and successfully imported cruciferous seeds into this country. The custom has become established, and most of them have more or less permanent trade relations with overseas exporters. Dealing with reputable firms they have had little or no worry, and we may presume the trade has brought them a reasonable measure of profit. No doubt these merchants would prefer to let well alone, and be disinclined to foresake the substance of sure profits for a scheme of local production. This, of course, represents a very real and serious difficulty, but there are two points which must receive consideration. In the first place, there is a possibility that the New Zealand farmer will demand New-Zealand-grown seed once its quality has been established, and in the second, as will be discussed later, there is no reason why those firms who have served us so well in the past, should not establish seed-producing agencies in this country.

Imports statistics show the bulk of our seed to come from Great Britain, but she has not, and cannot, produce all she exports. Much of the seed is produced elsewhere, mainly on the Continent, and re-exported from Britain. Therefore local production, which at first might seem rather damaging to the British farmer and the seed-producing firms at Home, need not necessarily result in a complete breakdown of the present organization, but rather a readjustment.

(3) PREJUDICES.

It is not easy to sense the demand for an article that is only just appearing on the market, nevertheless a large section of our farmers would prefer at all times to sow locally produced seed provided they could be assured of quality. Among farmers, at least, there is no prejudice against such seed. Merchants are perhaps a little more sceptical, and rightly so, since theirs is the greater responsibility.

Many people sense a mystery in the production of swede and turnip seed, and are suspicious of any that has not been produced in the older countries where for generations seed-growing has been practised. They fear that the New Zealand grower might omit to perform those ceremonies which result in the production of high-class quality. Without any desire to belittle those practices that mould type and influence quality, these are nevertheless merely the application of the principles of selection by men with special training and experience. We need in New Zealand pioneers to break through this conservatism, and are fortunate in now having one of our leading firms selling and recommending with every degree of confidence seed that has been produced in this country.

In 1931–32 samples of swede and turnip seed were collected from merchants throughout New Zealand, and grown at the Plant Research Station under careful observation. Most of the seed under test had been imported, but included in the trial were a few samples of New-Zealand-grown seed. This locally produced seed proved to be as pure and as productive as the best imported lines.

(4) OVERPRODUCTION.

Approximately 1,000 acres of turnips and 700 acres of rape should, in a favourable season, produce New Zealand's requirements. This would represent from eighty to ninety farmers each devoting about 20 acres to production of the seed. Seed yields are very easily upset by weather conditions, and we may expect production to fluctuate accordingly from season to season. On the other hand, local seed would be freshly harvested, and this would tend to minimize the danger of deterioration in any carry-over.

An export trade offers the most promising remedy for overproduction. If seed can be produced and sold economically in New Zealand an expansion would bring with it reduced costs, and we have the Australian market almost at our door. Export possibilities would no doubt be explored by merchants, and these certainly deserve consideration when reviewing the prospects of seed production in the Dominion. Nevertheless overproduction is a vital question. Extreme fluctuations in yield are common, and unless seed production is carefully organized there will always be the danger of both overproduction and underproduction.

(5) ORGANIZATION.

The contract system under which garden peas, beans, linseed, and other seeds are grown would no doubt prove to be the most satisfactory also for cruciferous seeds. The advantage lies in the possibility of controlling production both in regard to quality and quantity. To the farmer it has the advantage of giving him an assured market at a stipulated price. A grower would be taking undue risks were he to harvest seed before first being assured of his market and price. Moreover, it would be extremely inconvenient to merchants if free growers were to hawk seed from one possible buyer to another. No doubt a certain amount of free seed would be grown in any case, but the organization should come from the selling end, for only here could be determined what kind and what quantity to produce.

It would seem that in New Zealand we have an opening for two or three firms to undertake seed production on contract with farmers. This does not necessarily imply that they should be New Zealand firms, for the object would be attained as well, and perhaps better, were certain of the British seed firms to establish seed-growing agencies in addition to their selling agencies in this country. This suggestion has received consideration in the past, and it may need but little stimulus from this end to bring it into effect.

Efficient organization would also result in the careful supervision of field practice, and in the production of pure and high-quality seed.

The Position reviewed.

In reviewing the position one may well ask why the production of turnip, swede, and rape seed has not become more general. Without having to strike an unduly optimistic note, the possibilities certainly appear favourable. Nevertheless, the fact remains that several determined attempts at seed production have in the past met with disappointment.

There seem to be three possible explanations: Firstly, seed production requires the co-operative efforts of two parties—namely, the grower and the distributor. The grower should attend strictly to production, and produce only those seeds and those quantities which the merchant as distributor can effectively handle. The initial move should come, therefore, from the merchant; but too frequently it has come from the grower, and there has been a lack of co-ordination and no demand for the seed produced. Secondly, merchants have shown a disinclination to handle New Zealand seed because they have had no previous experience of it and could not offer it with absolute confidence. Finally, seed production is subject to wide fluctuations in yield. The total failure of a wheat crop may be regarded as a remote chance, but the total failure of a turnip seed crop is by no means so remote. Thus both the grower and merchant are taking a risk, the one in the loss of his crop, and the other in a lack of continuity of supply.

All these difficulties may be overcome by better organization, better methods, seed certification, and by spreading the seed crops over a wider territory to even up supplies. Certain of these points are to be discussed in the second part of this article.

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HAIRY FIBRES OF THE ROMNEY SHEEP.

I. HALO-HAIRS AND THEIR INHERITANCE.

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INTRODUCTION.

WOOL research at the Massey Agricultural College was started in 1928 in co-operation with the Department of Scientific and Industrial Research. The object of this series of articles, of which the present article is the first, is to put before sheep-breeders the essential facts that have emerged in one of the chief fields of research upon hairiness. The work is concerned with (1) the several types of hairy fibres, (2) the age at which each can be detected, and (3) the inheritance of the different kinds of hairy fibres. It is proposed to deal one by one with each group of hairy fibres of the first year's coat. For this fleece the main facts about the kinds of fibres and the time of their appearance are now known, and the first results of experiments on an accurate basis upon the inheritance of hairiness are now available.

Hairy fibres are classified on their structure and on the important events in their careers, more especially the time when they begin to grow, and whether or not at a certain age they cease growing and are shed. Fibres that closely resemble one another are placed in the same type, and the types fall into a small number of well-defined groups.

The recognition of these groups is not only essential in much experimental work, but should have a direct bearing upon the selection of animals, especially for stud purposes. It is just as important for a breeder to be acquainted with the main fibre types as to know the difference between true and false perennial rye-grass. Some of them are not easy to distinguish on the animal, but the main groups may be readily identified if a sample is examined indoors on a black background. If we know when particular hairy types make their appearance, or when certain features can be recognized, we can be on the look-out for them at the right time, and can apply this knowledge when judging the results of benzol testing at different stages in the development of the first year's fleece.

The following simplified list describes briefly the chief groups of hairy types that may be present in the lamb's coat :—

A. Present at Birth.

(1) *Halo-hairs and Allied Types.*—Hairy throughout ; halo-hairs very big, projecting above rest of coat at birth ; other types smaller ; nearly all shed in early weeks or months of life.

(2) *Hairy Sickle-fibres.*—Tip region shaped like a sickle and often hairy ; portion of fibre below sickle, and grown before birth, fine not hairy ; a longer or shorter part grown after birth hairy ; do not project above rest of coat at birth ; usually shed, in very varying proportions, at two to three months.

(3) *Hairy Curly-tip Fibres.*—Fibres with curly-tips of pure wool make up the great bulk of the coat at birth. In some cases these fibres continue to grow as pure wool, but in others they change over to the production of hair. It is the latter which are designated hairy curly-tip fibres.

Fibres which commence growth after birth do not possess tips with such pronounced and regular curling.

B. Begin to grow after Birth.

(1) *Successors of Shed Fibres.*—Follow in same roots, or follicles, the shed fibres of the foregoing groups; do not reach tip of staple, being found on opening the wool; some are shed, some continue growing; the hairy parts of the persistent fibres of this group vary greatly in length and in coarseness.

It is often convenient to refer to fibres of the first three groups simply as halos, sickles, or curly-tips. Sometimes the halo and sickle groups can be considered as a whole. The shed fibres of the first three groups are birthcoat kemps. The term kemp is applied to any hairy fibre that grows for only a definite limited time and falls out, whether it begins to grow before birth or afterwards. Secondary kemps are fibres that begin their growth after birth, following in the same roots as the birthcoat kemps.

All these groups demand serious and separate attention. The present article will discuss the first group, the halo-hairs and the types associated with them.

Halo-hairs and Associated Types.

There is good reason to believe that halo-hairs are the first constituents of the fleece to begin their development prior to birth. They project above the rest of the coat of the new-born lamb, so producing an effect suggestive of the object from which their name is taken. With the growth of the rest of the coat these fibres become less conspicuous at the age of a few weeks, and many of those on the back are soon broken, but even so docking time gives a convenient opportunity for judging lambs for this kind of hairiness.

Most halo-hairs complete their growth at about seven or eight weeks, and are shed during the next few weeks. In an occasional lamb a small proportion of the smaller halo-hairs are not shed, but continue to grow with or without a thin place at the stage of growth where shedding is usual (Fig. 1, *h* and *i*).

Halo-hairs from a central position on the britch are often noticeably long, resembling those from the back in Fig. 1, *a* and *b*. A few representative larger fibres are shown from the margin of the britch (Fig. 2, *a* and *b*), and some from the poll (Fig. 2, *c*) and the brisket (Fig. 2, *h* and *i*). The larger fibres from these extremities show little curling.

The halos of the back (Fig. 1) have a thin portion a little below the tip, though they vary a good deal in this feature. With an actual reduction in diameter is associated a squeezing together

a *b* *c* *d* *e* *f* *g* *h* *i*

FIG. 1. HALO-HAIRS FROM THE BACK: *a* TO *g* SHED, *h* AND *i* PERSISTENT. (LIFE SIZE.)

a and *b* are very large; *c*, *d*, *e* show pronounced thinning below tip region, while *f* and *g* show very slight thinning there; *h* has a slight thinning at the part at which halo-hairs are usually shed, while *i* has no such thinning.

a *b* *c* *d* *e* *f* *g* *h* *i*

FIG. 2. SHED BIRTHCOAT FIBRES FROM THE EXTREMITIES. (LIFE SIZE.)

a, *b*, longer fibres from the front margin of the britch; *c*, longer fibre, *d* to *g*, shorter fibres from the poll; *h*, *i*, longer fibres from the brisket.

[*Photos by H. Drake.*

of the walls of this part of these grossly medulated fibres; this squeezed condition has been found in an unborn lamb.

Intermediate between the birth-coat types, hairy throughout, in which shedding is very common, and the curly-tip fibres that all or nearly all persist and make up the great mass of the coat at birth, come the sickle-fibres, which are to be the subject of the next article. Hairy sickle-fibres (Fig. 3, *h*) are described now because they are placed in classification at the end of a series of transitional forms allied to halo-hairs. The tip region has the form of a sickle. The portion below the sickle is fine and not hairy, while the part of the fibre which is grown immediately after birth is thicker and hairy. Shedding is common among hairy sickle-fibres; sometimes all are shed, while occasionally, at the other extreme, all persist, every intermediate condition being found. Cessation of growth and shedding tend to be a little later than with halos. A series of the intermediates linking halos with sickles is shown in Fig. 3. These fibres are smaller than halos, and in some only a part of the thinned portion grown before birth contains medulla. They vary in size and in the degree and extent of the thinning.

Other comparatively short birthcoat kemps link up with halo-hairs, but appear not to have a place in the transition from halos to sickles in that there is little thinning below the tip region. The longer of these fibres are very little curled, and the same may apply to the shorter ones. Many of these fibres are much shorter than any shed hairy sickle-fibres. Examples from the back are shown in Fig. 4, *a* to *g*. They complete their growth at different times, earlier than halos, some having ceased to grow when the lamb is born. The shorter specimens often resemble very much the secondary kemps which do not appear until birthcoat kemps have been shed. Although these fibres may come loose very early there is very little risk of missing them at docking time. While these fibres are not found very commonly on the back, they are much in evidence on the extremities, examples being figured from the poll (Fig. 2, *d* to *g*).

The fibre shown in Fig. 4, *h* resembles the upper portion of some of the fibres that are transitional between halo and sickle. This fibre may, indeed, be looked upon as one of those intermediate fibres that instead of continuing its growth after birth has stopped growing altogether at the time of the pre-natal thinning. It is hoped to say more about this type of fibre in the next article.

Relation between Abundance of Halo-hairs on Different Body Regions.

The distribution of halo-hairs over the body is illustrated in the photographs of lambs. Just in front af the tail halos are sometimes specially numerous, sometimes less plentiful than farther forward. Compared with the rest of the back, the withers usually have noticeably few, but a very few lambs have many halos even there. On a small area on the back of the neck halos are often prominent (Fig. 6). They may be plentiful on the front of the neck or on the belly, as the same photograph shows. Almost always, if they are present at all, they are more abundant on the back than on

FIG. 3. SHED BIRTHCOAT FIBRES FROM THE BACK, SHOWING THE TRANSITION FROM *a*, SMALL HALO-HAIR, TO *h*, HAIRY SICKLE-FIBRE, WITH THIN PART BELOW THE SICKLE-END AND ABOVE THE HAIRY REGION GROWN AFTER BIRTH. (LIFE SIZE.)

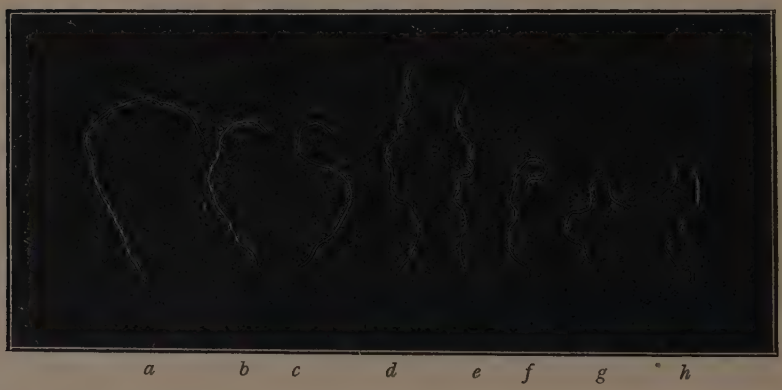

FIG. 4. SMALL SHED BIRTHCOAT FIBRES FROM THE BACK. (LIFE SIZE.)

Fibres like *a* to *e* complete their growth after birth, but before the halo-hairs cease growing. Fibres like *f* to *h* have completed their growth when the lamb is born.

[*Photos by H. Drake.*

the side. In this there is a sharp contrast with the distribution of the more common sort of hairiness plotted in Elphick's charts.* They may be in evidence on the foreleg.

* *N.Z. Journ. Agr.*, March, 1932.

Special attention has been paid to the britch, the poll, and the brisket. The abundance of halo-hairs on the back and on these extremities corresponds to a considerable degree. Notes have been made on about four hundred new-born lambs, a grading system being employed. The records have been tabulated and analysed, and it is hoped to publish elsewhere the evidence upon which the conclusions now to be stated are based. The photographs of lambs were taken to illustrate the differences in abundance on the back, but they also show the kind of differences displayed by the extremities. One's standard of judgment has to be a little more lenient to halo-hairs on the extremities than on the back.

Back and Britch.—On the whole there is a marked correspondence in grading between the back and britch of the same animal. Sometimes, however, the britch is freer from halos, sometimes it is worse, than would be expected from the abundance on the back. The lamb in Fig. 9, for example, has no halos on the back, but many on the britch. In general, if the britch is very free so also is the back. Indeed, if a clean britch is chosen, the whole of the rest of the body may largely be left to take care of itself.

Back and Brisket.—Abundance on the back and on the brisket largely corresponds, but even lambs that are very free on the back, and it may be on the other extremities, often have a conspicuous tuft on the brisket. Even more so than in the case of the britch great freedom from halos on the brisket is accompanied by absence or almost complete absence on the back.

Back and Poll.—There is a pronounced relationship between the abundance of halos on the back and on the poll.

Back and Tail.—Notes made on the tails of a smaller number of lambs indicate a correlation between the back and the tail; photographs provide examples.

On the whole it is found that relative abundance on any two of the regions considered in this section corresponds fairly closely. If the extremities are very clean there will be little in the way of halo-hairs on the back. It is to be noted that rigid selection for freedom on the brisket would give a bigger proportion of lambs free on the back than would equally hard selection on the britch, but such hard selection on the brisket would mean throwing out many lambs that were free from halo-hairs on the back. On present knowledge, therefore, the best plan would seem to be to pay attention especially to the back and the britch, going as far as is feasible in picking lambs with very few halos in those parts.

The Fibres which succeed Shed Fibres of the Birthcoat.

The performance of the birthcoat kemp follicles after the original occupants have ceased to grow must largely determine our attitude to halo-hairs and the associated sub-groups. It is hoped to deal with this subject more fully in a separate article. What is now said has reference to the back. If all the birthcoat fibres of these types were shed and followed by innocuous successors in the same follicles we should hardly object to them; in fact, in a hard climate a strain of such sheep might be in demand. In the Welsh Mountain

FIG. 5. LAMB OF MANY-HALO CLASS.
This lamb has halo-hairs extremely plentiful on the back.

FIG. 6. LAMB OF MANY-HALO CLASS.
This lamb illustrates the lower limit of abundance on the back for the many-halo class.

[*Photos by M. T. Gabriel.*

breed lambs are preferred with kempy coats as a protection against the weather, and Fraser Roberts has experiments in progress on a large scale in which animals are selected which have much birthcoat kemp but comparatively little secondary kemp. In this country, however, there does not appear to be any advantage in a kempy birthcoat in the Romney.

Roberts finds great differences in the extent to which animals kempy at birth sustain the growth of kemp in later life. The same is true in the New Zealand Romney. Some fifty lambs graded high for halo-hairs on the back have been followed closely. In some lambs most of the halo-hairs, and in a few lambs some of the stoutest of the shorter birthcoat kemps, are followed by secondary kemps, and these may continue to be grown one ofter the other throughout the first year and in subsequent life. These secondary kemps, which are usually 1 in. to 1½ in. long, are, no doubt, more familiar objects to breeders than halo-hairs, because they occur in sheep of any age beyond the first few months, whereas the halos are lost so soon. Most halo-hairs are much longer than these kemps of later life, growing as they usually do for a longer time, starting well before the lamb is born, and continuing to grow for about two months afterwards.

When halo-hairs are not followed by secondary kemps their successors may be hairy fibres that persist, more or less coarse, and the coarsest of these may be most undesirable. Some, however, are only slightly hairy, and in the detailed studies that involved marking the position of large numbers of individual fibres it was found that any fibres that could have been the successors of a few of these halo-hairs were not medullated at all. In some lambs the successors of the various smaller birthcoat kemps are on the whole hairy to a considerable extent, but less so than those of the halo-hairs.

For the present it may suffice to state the conclusion that the follicles of the halo-sickle group always make, amongst them, some contribution to the later hairiness of the fleece. Many hairy sickle-fibres, as has been stated, may persist. The extent of this contribution varies; sometimes it is comparatively slight, but frequently the successors of halo-hairs are secondary kemp, or very coarse hairy fibres that continue to grow.

It will naturally be asked whether a lamb in which this later hairiness of the halo-sickle group amounts to comparatively little should be retained for breeding. This question can be discussed adequately only in the light of the details that it is hoped to place on record shortly. It may be said, however, that there are definite reasons for advising the rejection of such lambs, endorsement thus being given to the practice of stud-breeders who dismiss at sight at docking time lambs with many halo-hairs without waiting to see what happens subsequently.

In considering the kempiness of an animal after the birthcoat fibres have been shed, the question arises whether kemp may at any time grow in follicles other than the original ones which contained birthcoat kemp. A definite answer to this question will probably come as a by-product of other work on the development of the fleece.

FIG. 7. LAMB OF CLASS WITH MEDIUM NUMBERS OF HALO-HAIRS ON BACK.

[*Photo by M. T. Gabriel.*.

a *b* *c*

FIG. 8. TUFTS OF WOOL FROM YOUNG LAMBS TO ILLUSTRATE THE RELATIVE ABUNDANCE OF HALO-HAIRS IN (*a*) THE MANY-HALO CLASS, (*b*) THE CLASS WITH MEDIUM NUMBERS OF HALO-HAIRS, (*c*) THE FEW-HALO CLASS.

[*Photo by H. Drake.*

Six lambs, free at birth from kemps coarser than sickle-fibres, were covered at an early age to prevent the loss of loose fibres. Observations were made on the growing fleece from time to time, and specimens taken were examined directly and in benzol. These examinations, and a less detailed study of other animals free from halo-hairs, point to there having been no later growth of kemp.

Failing tangible evidence for the opposite view it is safest to assume that kemp of late life is grown only in follicles that began to grow kemp before birth.

A few words may be added about succession in kemp follicles on other parts of the body. These have been studied less thoroughly than those of the back. Within the britch the story of succession appears to be much the same as on the back. Observations during the first and second years suggest that on the margins of the britch and on the poll and brisket the birthcoat kemps are succeeded by kemps more consistently than on the back.

This matter of succession has been dealt with at some length, though only in a preliminary manner, because it is important that the follicles that grow halo-hairs should be judged on their real merits. A lamb with many halos, but with fibres of the curly-tip group not hairy, may later show up very well; there are just such animals among the experimental sheep at the College. Yet if the elimination of hairiness is undertaken seriously it is suggested that selection against halo-hairs must be as keen as is practicable.

It is a pleasing fact that lambs with a great abundance of halo-hairs on the back are scarce, although observations have not yet been made among lambs in hill flocks. It has, indeed, been something of a task to find in the College flock, or in flocks visited in the neighbourhood, a sufficient number for research purposes, and gifts to the College of several such lambs have been much appreciated. Lambs with moderate numbers of halo-hairs are plentiful, and there is no difficulty in finding animals entirely free on the back.

Inheritance of the Abundance of Halo-hairs.

The lambing season of 1932 has brought the first results in breeding experiments designed to study the inheritance of the abundance of halo-hairs. The matings were made on the gradings for the back recorded during the first day or two of life, and the offspring were similarly graded soon after making their appearance. The animals are placed in four classes according as they have many halos (Figs. 5 and 6), medium numbers (Fig. 7), few, or none (Figs. 9 and 10). It is not easy to bring out the halo-hairs in a photograph of a lamb of the few-halo class, so a further indication of the relative abundance of halo-hairs in the three classes that possess them is given by tufts of wool from each (Fig. 8). In the grading the lambs were judged by eye, but counts show that, roughly, those in the many-halo class had one halo-hair to fewer than 150 curly-tip fibres, one lamb having a halo-hair to every twelve curly-tips. By medium numbers is meant one to from 150 to about 2,000 curly-tips, lambs in which halo-hairs are less plentiful than this being classed as having few.

Three experiments were performed, in each of which like was mated with like, the three classes bred from having (1) many halos, (2) medium numbers, and (3) none. To mate like with like is essential as the first step in experiments on the mode of inheritance of characters. The breeding results are shown in the following

FIG. 9. LAMB OF NO-HALO CLASS.

Although there are no halo-hairs on the back, there are considerable numbers on the britch and many on part of the tail.

FIG. 10. LAMB OF NO-HALO CLASS.

In addition to having no halo-hairs on the back this lamb has the extremities very clean.

[*Photos by M. T. Gabriel.*

table, in which are included a small number of lambs born in other experimental breeding the previous year :—

Parents : Both having—	Numbers of Ewes lambing.	Offspring : Numbers of Lambs having—			
		Many Halo-hairs.	Medium Numbers of Halo-hairs.	Few Halo-hairs.	No Halo-hairs.
Many halo-hairs ..	13	6	5	2	..
Medium numbers of halo-hairs ..	16	2	13	5	..
No halo-hairs ..	11	..	..	4	9

The results are of the kind one would expect in the light of breeding experience in general, and on the assumption that several hereditary factors play a part in determining the abundance of these kemps. The more halo-hairs the parents have the more, on the average, have the lambs. At the same time many-halo parents throw some lambs with few halos, occasionally much fewer, while some lambs from the no-halo parents have a few halos instead of none. Parents with medium numbers have produced lambs mostly graded the same, but also some with many and some with few. In the many-halo experiment one lamb is outstanding in having more halo-hairs than either parent.

It is clear, therefore, that the sheep bred from in these experiments were by no means pure for the hereditary factors that were being studied, for in the passage from one generation to the next the shuffling and sorting of factors with which Mendelism has made us familiar has taken place. Considering the results from the practical point of view, it is to be emphasized that selection in both directions —for many halos and for none—has been effective, and especially so in the no-halo flock. In this experiment only four of the thirteen lambs had any halos on the back ; on these four they were very scarce, two lambs having only a single specimen on the back.

Little need be said about the inheritance of halos on the extremities. In the no-halo mating the extremities were very clean in both generations.

Summary.

(1) A beginning is made in describing the main groups of fibre types of the Romney lamb, with special reference to hairiness.

(2) There is evidence that halo-hairs when present are the first fibres to begin their development, well before birth. At birth they project above the rest of the coat, so that their abundance can be observed at a glance either then or at docking time. Some smaller fibres of allied types may be shed very early, but there is little risk of their being missed at any age at which docking is usually done.

(3) There is considerable correlation between the abundance of halos on the back and on the extremities. Occasionally the britch is graded proportionately lower than the back, while more often lambs with few halos on the back have a good many on the britch. The brisket is especially prone to a thick tuft. If the extremities are very clean the back also will be very free.

(4) Halo-hairs are nearly all shed in the first two or three months, together with many fibres of associated types. They are succeeded in the same roots by other fibres. In the lambs studied the follicles containing halo-hairs and allied fibre types at birth always made some contribution, apart from the shed birthcoat kemp, to the hairiness of the first fleece. In lambs having many halo-hairs this later contribution is sometimes of serious consequence, sometimes only slight.

(5) A fuller discussion of the degree of undesirability attaching to halo-hairs is postponed until further facts about sickle-fibres and succession in kemp follicles have been presented. Enough has been said to show that from the point of view of the total hairiness of the fleece the ideal is to have as few halo-hairs as possible.

(6) The results of breeding experiments on the abundance of halo-hairs indicate that this depends upon several hereditary factors. In these experiments selection both for many halo-hairs and against them altogether has been largely effective.

Conclusion.

In breeding practice some selection is carried out against halo-hairs, but even in stud-breeding this is often by no means rigid. Lambs with many halo-hairs on the back will generally be thrown out, but a lamb with moderate numbers on the back and a considerable amount on the britch frequently stands an excellent chance of being retained. Just how exacting selection can be must depend upon many considerations, but it must be emphasized that halo-hairs may be followed by kemp or very objectionable coarse hairy fibres; that the presence of halo-hairs promises at least some hairiness in the first fleece; that their presence depends upon hereditary factors and selection against them has proved very effective; and, finally, that they can be seen at a glance in the early days of life. In a systematic drive against hairiness this comparatively easy prey should not be allowed to escape.

In conclusion, two points are to be stressed. Firstly, in breeding practice, as well as in research, it is clear that the different groups of hairy fibre types will have to be dealt with, not only in the mass, but separately. Secondly, the results obtained in selection against halo-hairs encourage the hope that all kinds of hairiness will largely yield to rigid culling. It is the aim of a number of lines of work now in progress to make selection easier, more accurate, and more effective.

Check-testing of Suppliers' Milk and Cream Samples at Dairy Factories.—The following reference to this activity is made in the annual report of the Dairy Division for 1931–32: "During the year some 580 visits were made to dairy companies for the purpose of check-testing suppliers' samples of milk and cream for butterfat content, this work being undertaken by two special officers, assisted by the Dairy Instructors as far as their instructional work permitted. A general desire is evidenced by factory-managers to carry out this work accurately and efficiently, and a survey of the check-tests received from our officers indicates that companies are testing on approved lines. The testing-appliances at many factories have, since the inception of this check-testing, been much improved, and the general position from the standpoint of the milk and cream suppliers can be considered satisfactory."

SOME FACTORS IN THE AVAILABILITY OF GROUND LIMESTONE AS PLANT FOOD.

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GROUND limestone, which is often sold under the name of carbonate of lime, consists of more or less finely divided limestone. The fact that carbonate of lime is very readily lost by leaching*, and that New Zealand soils are characteristically deficient in lime, has long been recognized. In order to combat this deficiency it is necessary to top-dress with lime, and the many accessible deposits of high-grade stone make this possible at a very reasonable cost. A factor of great importance in the use of ground limestone is the chemical availability of the stone used. This depends primarily on three factors: (*a*) The calcium carbonate content, (*b*) the fineness of grinding, and (*c*) the mineral character of the stone, including hardness and solubility. All three factors are more or less interdependent.

Naturally the most important consideration in the use of ground limestone is its calcium carbonate content. In most districts limestone between 90 and 100 per cent. carbonate content is available†. Commercial crushed limestone, however, does not always come up to this excellent level. The analyses usually range between 70 and 98 per cent., while samples as low as 40 per cent. calcium carbonate have been received. Obviously the use of ground limestone of lower than 70 per cent. purity, which involves the cartage and distribution of 30 per cent. or more of inert material, is not economic, except where other factors enter into the problem. Thus it is generally found that New Zealand limestones of high calcium carbonate content are very hard, while low-grade stones are softer. Many soft greyish limestones vary between 50–80 per cent. of carbonate ($CaCO_3$), whereas the majority of hard greyish stones tested vary between 70 and 90 per cent. Among the many exceptions to this generalization are the notable examples of calcareous sinter, common in the Wairarapa and some other districts, and usually giving a value of over 90 per cent., and chalk which only occurs in Canterbury and Marlborough.

Many of the soft stones of lower calcium carbonate content require very little crushing, while many of high purity (*e.g.*, marble) are very

* Some of the lime in the soil is held in combination in the clay particles, and is known as "replaceable" lime. This lime is much less soluble than carbonate of lime in the weak carbonic acid of the soil water. Consequently in heavy clay soils, which are often considerably unsaturated as regards replaceable lime (having a high lime requirement), the loss by leaching of applications of carbonate of lime is retarded.

† The large area of pumice country extending from the Bay of Plenty to Lake Taupo and the Waikato is practically devoid of deposits of limestone. It is therefore fortunate that both practical experience and laboratory investigations have shown the greater part of this land to be in no need of lime, the easily weathered, geologically "recently" ejected pumice supplying, in conjunction with the calcium provided in phosphatic fertilizers, all the lime needed for plant and animal nutrition. The application of additional lime in the form of carbonate and hydrate has proved to be prejudicial to stock wherever bush sickness occurs.

resistant. Thus where a farmer is exploiting his own deposits, and where the chief expense is that of crushing, it may be better to use a softer though poorer stone than to go to considerable expense in crushing a higher-quality stone. Another point to be considered is the problem of transport. In some districts—for instance, in parts of Canterbury—it is found that while there is an abundance of limestone from 60 to 80 per cent. carbonate the occurrence of richer deposits is rare. In such districts the prohibitive cost of transport of higher-grade limestone from a considerable distance renders the use of local lower-grade stones advisable.

There is a considerable variation in the fineness of grinding of limestones in this country. A consideration of a large number of samples shows that in many a considerable fraction is retained on the 2 mm. sieve (10 meshes to the linear inch)—up to 20 per cent. or more in some cases. The coarse material retained on a sieve with 60 meshes to the linear inch is found to average about 50 per cent., while the amount of the material passing a 120-mesh sieve is 25 per cent. Since there are as yet no recognized standards for fineness of grinding in this country, it is interesting to compare such values for New Zealand ground limestones with those of other countries. One tentative standard in the United States requires that 75 per cent. shall pass through a 100-mesh sieve. Knibbs, in "Lime and Magnesia," suggests that limestone ground so that all passes a 60-mesh sieve, with a considerable percentage passing 100-mesh, is most suitable for general purposes. It will be noticed from this that in general the ground limestone in New Zealand is coarse in comparison with that of other countries. This, however, may not be altogether a disadvantage, owing to the acid nature of our soils and generally heavy rainfall.

For another reason it may be more economic in many cases to use coarsely ground stone. Where the source of supply is close it may be cheaper to use a much larger quantity of coarser stone. In this way the same results as with a smaller quantity of finely ground stone are secured, and in addition the soil is stocked with a store of coarse material which will be utilized slowly over a number of years. The extreme view is that taken by Hopkins (see this *Journal* for March, 1918, p. 162), who considers that the most economical material to use is that which all passes a $\frac{1}{4}$ in. screen and contains all the fine material produced. This, however, is for conditions in the United States, where the low cost of grinding due to large-scale output (often as a by-product in making road metal), and the cheap transport and distribution due to mass consumption and the topographical nature of the country, enable large quantities to be applied at small expense. Where, however, carriage and distribution costs are high, or where a quick response is desired, the use of a finer product is advisable.

Although New Zealand soils may not require limestone ground to the same degree of fineness as many other countries, the benefits of standards of fineness cannot be overlooked. It is tentatively suggested that the following limits could be observed with advantage: Not more than 2 per cent. retained on 2 mm. sieve, not more than 20 per cent. retained on a 30-mesh sieve, and at least 50 per cent. passing a 60-mesh sieve. While the majority of ground limestones would comply with these conditions there are a number of others that would require finer

crushing. It is extremely desirable that some standard of fineness should be recognized ; a good limestone to fulfil the foregoing conditions does not require extreme crushing, and at the same time should be suitable for most of the soils of this country.

The solubility of ground limestone is dependent on several factors. The first of these is fineness of grinding. Thus the rate of solution of limestone depends on the surface area exposed, and this in turn depends on the fineness of grinding. The smaller the particles the greater the surface area exposed. Bulletin 531 of the Cornell University Agricultural Experiment Station brings together much data from pot and field experiments on crop yield over varying periods of time with different particle sizes and types of ground limestones applied at various rates. In one case where a soft limestone was used the maximum yield was obtained with the 50- to 80-mesh fraction, while the yield from the 10- to 25-mesh fraction was nearly as great. A marked reduction occurred with the 5- to 10-mesh fraction, and a slight reduction with the fraction passing the 200-mesh sieve. The latter effect was believed to be due to the rapid removal of the finest particles from the soil by leaching. In similar experiments with harder limestones the maximum effect was not obtained till the material passing a 100-mesh sieve was used, while that below 40-mesh was comparatively ineffective. It therefore appears that hard limestones should receive finer grinding than soft ones.

Interesting experiments verifying the conclusion that the rate of solution depends on the exposed surface area of the lime particles, were published in *Industrial and Engineering Chemistry* for September, 1932. Plots were treated with crushed limestone of definite particle size, and the amount used up was obtained at twelve monthly intervals. It was found for the initial period that particles passing a 48-mesh sieve and retained on a 65-mesh sieve dissolved ten times as quickly as particles passing a 4-mesh sieve and retained on a 6-mesh sieve.

Another factor in the solubility of limestone is the hardness. A hard fine-textured stone offers much less surface than a soft, friable, and often porous stone. Thus a compact limestone requires much finer pulverization than does a soft easily weathered stone. With the poorer-quality stones the inert material, by means of its shielding effect, may retard the solution of the limestone. Owing to the conflicting principles involved there is no recognized way of evaluating the solubility of limestones. Should, however, the investigations proceeding in various research institutions lead to the discovery of a suitable method, it might be possible, after comparison with field trials, to devise a technique for determining the availability of different ground limestones as plant-food.

NOTE.—The sieves referred to in this article are all described in terms of the approximate number of meshes to the linear inch, except where otherwise specified.

Light tumbler sweeps found favour with many farmers making ensilage last season, and proved very effective under widely different conditions. They were also used effectively for bringing in hay.

THE RABBIT PEST AND ITS CONTROL.

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POTENTIAL INCREASE OF RABBITS.

IN order to fully understand the danger of the rabbit pest and to appreciate the relative value of the various methods of control, it is necessary that farmers should realize the extent to which rabbits are capable of increasing in a given time, and for this purpose breeding particulars in respect to a period of three years are here given. The following recognized authorities may be quoted in support of the figures on which these calculations are based: "Encyclopædia Britannica," "Treasury of Nature" (Mander), "Veterinary Posology" (Banham), "Veterinary Obstetrics" (Williams), "Fleming's Veterinary Obstetrics," and "Harmsworth's Encyclopædia," the latter stating that, if left undisturbed for a period of three years, the progeny of one pair of rabbits would amount to not less than thirteen millions. All agree on the main issue—*i.e.*, the gestation period, average number in litter, &c.

The authorities named deal more particularly with the breeding habit of the rabbit in European countries, but under the more congenial climatic conditions existing in New Zealand the rate of increase is more rapid. There is no doubt that the number of litters a doe will produce in a year is largely dependent on climatic conditions. In the southern portions of the Dominion where the winters are more severe there is a distinct break of some months between breeding seasons, whereas in parts of the North Island, particularly in the warm coastal country, it is not uncommon to find rabbits breeding throughout the winter months, and under such conditions it is possible for a doe to produce as many as ten litters in a year (the period of gestation being twenty-eight to thirty days). From records kept and observations made over a period of many years it has been found that six is a fair average litter, which number may for all practical purposes be taken as reasonably correct.

Assuming, then, that the average litter is six, that each doe will produce in the year eight litters of equal sexes, and that the young does will breed at fifteen weeks, the total increase for the year from one pair would be 534. This total is contingent upon there being no casualties; but, allowing that from all causes 50 per cent. of this increase will become casualties before the beginning of the second year, the second breeding season would thus commence with a total of 267, plus one of the original pair, a total of 268. Half of this number, 134, are does, each producing an increase of 534 in the season: $534 \times 134 = 71,556$. The casualties during the second year and succeeding years would be less than in the first year, as the toll taken by the natural enemy would not increase in proportion; but, allowing that the losses remain at 50 per cent., the third year would start with half the previous year's increase = 35,778, plus 134 (with which the second season started) = 35,912. Half of these, or 17,956, are does, each giving an increase of 534

in the year: 17,956 × 534 = 9,588,504. To this must be added the number at the beginning of the season—namely, 35,912—showing a total of 9,634,416 at the end of the third year.

It will thus be seen that it is reasonably possible for one pair of rabbits to increase in three years to between nine and ten millions. This is a fact which it would be well for every settler to fix very clearly in his mind. The figures stated present an interesting problem. It is estimated that six or seven rabbits will eat or destroy as much grass as would graze one sheep; but, allowing that ten rabbits equal one sheep, it is evident that one pair of rabbits is capable of reducing in three years the stock-carrying capacity of our lands to the extent of a million sheep.

Economic Loss from the Pest.

Rabbits are keen judges of pasture, their movements are not restricted by ordinary stock-fences, and, having a more or less free choice, they select the sweetest and most nutritious grasses. Therefore the stock-feeding value of the pastures largely depends on the freeness of the lands from rabbit infestation. The economic loss to this Dominion through the depredations of the rabbit pest is extremely large, running into millions of pounds each year. Over a ten-year period, 1920 to 1929 inclusive, the number of rabbit-skins exported was 149,450,537. Those exported represent considerably less than half the rabbits actually destroyed, to which must be added the number still remaining. Assuming that six or seven rabbits do equal one sheep, and estimating the value of a sheep at 10s. per year during the period mentioned, one can more readily appreciate the annual loss from faulty or inadequate control of the pest.

System in Attack.

Ordinary farming operations are carried out in season according to a preconceived plan as dictated by seasonal conditions; lambing will commence and the dairy herd come to profit at a time when the best results may be expected with a minimum of risk, and in dealing with the rabbit pest the same principle should be adopted, the expenditure and effort being applied at the seasons which will give the best results.

The seasons at which the attack on the pest should be made and sequence in which the various methods of destruction should be applied will have an important bearing on the success or failure of the year's work. The general breeding season will commence about the beginning of August and continue till the end of March. Saturation point in the season's increase (although not matured) will be reached in March, and there then remains approximately four months in which to reduce the pest to a minimum without fear of reinforcements. Therefore the early autumn and winter poisoning should be regarded as the starting-point in the year's operations.

Methods of Destruction.

The next point to consider is how can the greatest number of rabbits be destroyed in the shortest time possible at a minimum of cost. A variety of methods are available—namely, poisoning by phosphorized pollard, jam poisons, and strychnined pollard, carrots, oats,

swedes, or apples; gassing with carbon bisulphide or cyanogas; traps; dogs; gun; and ferrets. Each and all of the methods enumerated may be usefully employed if applied at the correct season and in the proper sequence. A brief study of each will serve to determine their relative value and the sequence in which they should be used.

Phosphorized-pollard poison, and strychnined-pollard poison: In 1 lb. there are over 250 pellets, each containing poison sufficient to destroy at least one rabbit. One man can spread in one day 20 lb. to 25 lb. and cover from 100 to 150 acres. Allowing that one quarter of the poison is not taken, it would be reasonably possible for one man on badly infested country to destroy in one day over three thousand rabbits. Approximate cost—poison 11s., labour 10s., a total of 21s.

Jam poisons: The bait is one small teaspoonful or about one hundred baits to the pound. One bait is sufficient to destroy one rabbit. One man can lay in a day 12 lb. to 14 lb., covering 60 to 80 acres, and may destroy 800 to 1,000 rabbits. Approximate cost—material 13s., labour 10s., total 23s.

Strychnined carrots, oats, swedes, apples, or pollard: With these kinds of poison it is very desirable to feed for two or three nights with unpoisoned baits before laying the poison. The area which can be treated in one day is more limited, approximately 40 to 50 acres. One man can spread 15 lb. to 20 lb., and may destroy 700 to 1,000 rabbits. Approximate cost—material 8s., labour 10s., total 18s.

Gas (fumigation of burrows): With carbon bisulphide the quantity required will depend entirely on the size or extent of the warren, but as a general average 1 gallon will be sufficient to treat eighty burrows. On easy grasslands one man may treat in one day eighty to a hundred burrows and destroy all rabbits therein. Approximate cost—material 12s., labour 10s., total 22s.

Cyanogas (calcium cyanide): The cost and effect are practically the same as with carbon bisulphide.

Traps: An experienced trapper can set eighty to one hundred traps, and in badly infested country may destroy one hundred rabbits in one night. Cost of labour, 10s. (See further reference to the use of traps later on.)

Dogs, ferrets, and gun: These methods are suitable only on lightly infested open country.

Rabbit-proof fences: These are suitable on any country, both for boundary-fences and for subdividing the property into smaller areas. Much benefit will be derived from them, both for assisting in the eradication of the pest and for preventing the incursion of rabbits into clean areas from adjoining infested lands.

From the foregoing analysis of the various methods it will be seen that phosphorized-pollard poison is the quickest and cheapest method of wholesale rabbit destruction, but in order to obtain satisfactory results certain conditions are essential. The rabbits must be undisturbed and unsuspicious of danger. The poison must be laid when weather and pasture conditions are suitable. Dry hot summer weather is not suitable, and continuous wet weather is equally

unsuitable. The best results will be obtained just before the autumn growth sets in, while the pastures are bare and the weather is cool and moist.

The freshly turned sod or furrow will then be more attractive and the bait will remain softer and more palatable. One or two pellets (not more) should be laid on the cleanest part of a newly turned sod; these should be placed at intervals of 3 to 6 yards, according to the extent of infestation, in lines about 1½ to 2 chains apart. When laying the poison the hands of the operator must be kept clean. Rabbits will not touch poison tainted with oil, fat, tobacco, &c. Avoid skinning dead rabbits while engaged in laying poison. Satisfactory results from the use of poisons *will not be obtained* on country recently disturbed by trapping, dogging, or shooting. Rabbits should be disturbed as little as possible for at least two months before poisoning operations are commenced, and when the work is commenced it should be continued and completed as quickly as possible throughout the whole of the infested area.

Any one variety of poison will not destroy all rabbits. The bait that may be palatable to the majority will not be suitable for all. Following the general poisoning with phosphorized pollard, jam poisons or strychnined carrots or oats should be laid in patches where phosphorus has failed, and, given a variety of poisons at intervals of three or four weeks very few rabbits will escape. As an alternative to the use of phosphorized pollard, many farmers will prefer to use strychnined carrots, oats, pollard, &c., for the general poisoning, and in regard to these, the foregoing remarks will also have general application.

Having reduced the pest to a minimum with the use of poisons—which is the quickest and cheapest method of destruction—all burrows should be closed and other cover destroyed as far as possible. Do not waste gas on empty burrows. Close them first, and any that are reopened should be then treated with carbon bisulphide or cyanogas. Traps, dogs, and gun may now be profitably used to clean up the stragglers that have so far escaped. Remember that every doe destroyed now will prevent a possible increase of hundreds before the end of the season. The importance of destroying all burrows cannot be overestimated. While this class of cover is left the danger of reinfestation remains.

Traps, dogs, and gun are useful if employed at the proper seasons as an aid to poisons, but on no account should they be employed immediately before poisoning. On recently trapped country very few rabbits will be seen. The effect is generally misleading, and is more apparent than real. Seventy-five per cent. of the rabbits may have been caught, but the remainder are frightened and will keep underground or move to cover, and will not venture out till after dark. In this condition they are suspicious and will not take poison. The stock thus carried over will quickly reinfest the neighbourhood and no permanent progress is made.

A frequent repetition of poisonings with the same kind of poison is usually a waste of time and material. If sufficient poison is laid when poisoning conditions become suitable, and a certain number of rabbits escape, it should be evident that they will not take the same

class of poison if laid again a few weeks later. Some other kind should be used. After a lapse of two or three months a second poisoning may be made, but if done too frequently with the same class of poison the best results will not be obtained.

Phosphorized-pollard poison may be taken by the rabbits for several days after laying, and should not be covered for at least three or four days.

Fumigation of Burrows.

On open grasslands where the cover is mainly warrens, fumigation with carbon bisulphide or cyanogas is easily the most effective method of destruction if used under suitable conditions. The best results will be obtained in calm weather while the soil is wet. On pumice or open sandy ground satisfactory results will not be obtained in hot dry weather, when the gas will readily escape through the porous dry soil, and may not reach the farthest recesses of the warren. Before treating the burrows the surrounding country should be thoroughly hunted with dogs to drive underground any rabbits that may be outside.

Carbon bisulphide, if properly used under suitable conditions, will prove 100 per cent. effective and gives the enemy no option. An empty poison tin with a close-fitting lid may be used to carry the material when treating burrows. Fill the tin with pieces of sacking about 6 in. square, pour in sufficient carbon bisulphide to thoroughly saturate the sacking, then add sufficient water to cover the carbon bisulphide so as to prevent evaporation. When the burrow is reached put one piece of sacking well into each entrance, close with earth, and tramp hard to prevent the escape of gas.

Cyanogas has also given equally good results when used under suitable conditions. This material is obtainable in both the dust and granulated form, the former being blown into the burrow with a suitable pump and the latter being used by placing a spoonful well in on the floor of the burrow, in each case the mouth of the burrow being well closed and firmly tramped. The granulated form is most favoured, as no special appliance in respect to its use is necessary.

Preparation and Use of Phosphorized-pollard Poison.

Recipe No. 1.—Boil 3 quarts of water and $4\frac{1}{2}$ lb. of brown sugar in a clean oil-drum or kerosene-tin. When the liquor is boiling take it off the fire and put in two sticks of phosphorus (about 4 oz.). After allowing a minute or so for the phosphorus to thoroughly dissolve, boil the whole again. Then lift it off the fire, and immediately begin stirring in pollard. Stir hard, as this is the time to get the phosphorus well distributed. Continue adding pollard until the mass becomes sufficiently stiff for kneading.

For large quantities the proportions required are as follows: 18 lb. sugar, 1 lb. phosphorus, 3 gallons water, with sufficient pollard (about 60 lb.) to make a stiff dough.

Recipe No. 2.—Put, in a pickle-bottle, preserving-jar, or a tin with a tight-fitting lid, 1 tablespoonful of carbon bisulphide and $1\frac{1}{2}$ sticks of phosphorus, with $\frac{1}{2}$ pint of cold water. Allow this to

stand till the phosphorus is thoroughly dissolved. In 3½ pints of hot water dissolve 3 lb. of sugar. Pour both these mixtures into a clean vessel and stir well; then add pollard until the dough becomes stiff enough for kneading.

For large quantities the proportions required are as follows: 4 tablespoonfuls (2 oz.) carbon bisulphide, 16 lb. to 18 lb. sugar, 1 lb. phosphorus, 11 quarts water, and sufficient pollard (about 60 lb.) to make the dough stiff enough for kneading and dividing into cubes. When making large quantities by hand the cutting is generally done with a disk-roller cutter. A poison-mixing machine is also on the market, which does the whole of the mixing and cutting into cubes. This machine is suitable when large quantities of poison are being manufactured.

With either recipe if the weather is extremely dry it is better to use one-third less sugar, and substitute an equal weight of treacle. This will prevent undue drying and hardening.

Preparing the Baits.—Use a clean board and roller, and keep them well dusted with dry pollard. Take a quantity of the dough out of the vessel with a spade or flat stick, throw dry pollard on it to stop any sparking, knead it, and roll it out to ¼ in. thickness, Then cut it into ½-in squares and throw the ragged edges back into the vessel. Gather up the squares and place them in a shallow box or tray, sprinkle over with some dry pollard, and allow them to dry out before tinning up or using.

Laying the Poison.—One way of laying the poison is by turning a sod with a spade or adze and placing one or two squares on top of it. Some prefer placing the baits in the holes made by the spade or adze. Another way is to lay them at intervals in a plough-furrow. The number of baits laid must be according to the state of the rabbit pest.

On bare run-country the poison may be laid without using spade, adze, or plough, the baits being dropped on the barer patches of ground. This method has proved satisfactory in many cases, but more poisoned baits require to be laid than with the other methods, as there is no freshly turned earth to attract the rabbits to the baits.

Phosphorized Grain.

Recipe and Preparation.—Take 120 lb. of grain, 18 sticks (2 lb. 4 oz.) of phosphorus, and 4½ to 5 gallons of water; 9 lb. of sugar is also added in most cases, but the poison is said by some users to be equally well taken without this. The water is boiled in an iron cylinder, which is fitted with a spindle and set up on iron posts or frame, a fire being lighted beneath it. When the water is boiling, the phosphorus is put in and stirred until every particle is thoroughly dissolved, after which the grain is poured in and the lid screwed on tightly. The cylinder is then turned slowly and steadily for twenty minutes or more (the fire being put out after about ten minutes' turning), again turned for a few minutes every half-hour for an hour or two, and then given a few turns several times during the remainder of the day. The poison should be left in the cylinder

for at least twenty-four hours if possible, and preferably a little longer. If taken out too soon the fumes are very strong and dense and unhealthy to work in, and it takes twenty-four hours to thoroughly impregnate the grain with the phosphorus.

Where no iron cylinder is available the grain can be boiled in clean drums or tins for ten minutes, and then put into a barrel with spindle and turning-handle affixed and set on a frame or posts. This barrel must be provided with a manhole on its side, which must be fitted with an airtight lid to prevent leakage of fumes. The barrel should be rotated at intervals in the manner already explained, and left for at least twenty-four hours before removal of the poisoned grain.

Some makers prefer to soak the grain (especially if barley is used) for twenty-four hours in cold water before boiling, in which case less than the above-stated quantity of water will be required for boiling it. In connection with the sugar constituent, some prefer not to boil this with the grain, but to mix it with the poisoned grain on the day of laying.

If kept in an airtight container the poisoned grain will remain good for some time.

Laying the Poison.—Lay the rows about a chain apart, and deposit on barest parts of the ground about a dozen grains every few yards. In many cases it will be found advisable to lay the grain on freshly turned sods or in plough-furrows.

Strychnine Poisons.

Carrots as Bait.—Poisoning in this form is very effective in winter, when the carrots are fresh and crisp. If carrots are allowed to become soft and dry the rabbits do not eat them so well. The methods adopted are as follows:—

(1) Strychnine and sugar sprinkled: Cut up 15 lb. of carrots into small cubes, add 1 lb. of icing-sugar, but no strychnine, and drain off any liquid after sugar has dissolved. Lay the sweetened cubes in freshly made light plough-furrows, spade chips, or scrapes, two cubes every 2 to 3 yards apart. Feed in this manner for two or three nights, and if the rabbits eat the carrots proceed as follows: Cut up 12 lb. of clean carrots into small cubes, add 1 lb. of icing-sugar, and allow carrots to drain until all surplus liquid runs off; take 1 oz. of finely powdered strychnine and sprinkle a teaspoonful at a time over the carrots until the ounce is all mixed, stirring well after each application of strychnine; then add 1 lb. of icing-sugar to cover taste of strychnine, and allow the carrots to stand for two hours before laying. One poisoned cube every 3 yards is sufficient.

When large quantities are being dealt with the carrots may be cut into cubes by being placed in a strongly made box and chopped up with a spade, then put through a sieve to take out the larger pieces for rechopping. The method of mixing the chopped carrots and sugar (without strychnine) is to place alternate layers of carrots and sugar in the box, and thoroughly stir up and mix together. When the poisoned baits are being prepared, mixing is done in the same way, with the addition of a sprinkling of powdered strychnine on each layer of carrots and sugar, the whole being thoroughly

mixed together before removing from the box, so that each piece of carrot may get its share of the strychnine. If this mixture is considered by the user to be too strong it can be weakened by the addition of a few pounds more carrots.

Minced carrots are sometimes used instead of the chopped-up article, and, where laid fresh, results have been found satisfactory.

Commence operations, as stated earlier, by free-feeding the rabbits for two or three nights in succession with unpoisoned carrots. Liberal free-feeding for at least two nights is strongly recommended—in fact, it is practically essential for success. The baits in free-feeding should be similiar to those which are poisoned, and should be laid in the same way. If the baits free from poison are well taken, lay the poisoned carrots on the third day; if not, free-feed for a third day. It has been found advisable to put out at least twice the quantity of free-feed as compared with that poisoned. The poisoned baits should be laid from about 6 ft. to 9 ft. apart, according to the infested state of the land.

(2) Strychnine and sugar paste: The mode of preparing the poison is as follows: To 1 oz. of powdered strychnine add 2 oz. of icing-sugar, and after thoroughly mixing this add enough water to make a thick paste. (Note: If strychnine crystals are used they will require to be powdered before adding the sugar. The greater portion of the strychnine sold for rabbit destruction purposes is already powdered ready for use.) A bottle with wide neck and glass stopper is most suitable for mixing the poison paste, but any small tin or suchlike receptacle will do.

Free-feed with unpoisoned carrots two or three days before poisoning. When ready to commence laying the poison have the carrots clean. Cut the carrot straight across the top with a clean knife, smear the top of the carrot with a little of the poisoned paste, and immediately commence slicing off the baits, so that each bait will have at least a smear of the poison. When all the smeared part is cut from the carrot, again apply the paste as before. The baits should be thin, not more than $\frac{1}{8}$ in. thick and about $\frac{3}{4}$ in. across. Each bait only requires a very small portion of the paste-smear.

In each case all unpoisoned cubes should be gathered up before the poisoned baits are laid.

It is preferable to lay the poisoned baits in the afternoon, and if rain comes on and the result is spoiled in consequence, immediately relay when the weather is again fine. All stock should be removed before poisoning, and if any poisoned baits are left after two or three days gather up and bury them. Carrots should be of good quality and clean cut, not bruised.

It may be noted that apples and swede turnips have been successfully used in place of carrots in the foregoing methods.

Oats and Molasses as Bait.—This method has proved very effective, satisfactory kills having been made, and it can be used at any season of the year. It has been tried when there was abundance of pasture, also when feed was scarce, and in both instances results were good. The method is as follows:—

Boil 15 lb. of oats (Garton's preferred) with 2 lb. of molasses or treacle and sufficient water until the oats are soft, draining off any

surplus liquid. The oats are then ready to lay for free-feeding purposes. Run light plough-furrows about 2 chains apart on the land where rabbits feed principally at night, and lay baits of a dessertspoonful every 4 yards apart in the furrows. In country too rough for the plough lay the baits in scrapes or spade-chips. Continue this for two or three nights, and if the rabbits are then eating the sweetened oats well, proceed with the poison as follows: Weigh out 24 lb. of boiled oats, treated as before mentioned; pour into a wide bath or tub; take 1 oz. of powdered strychnine and sprinkle a teaspoonful at a time over the oats, stirring well after each sprinkling until the strychnine is all mixed in; after which add 2 lb. of sugar to give a sweet coating. As the rabbits have been fed on sweetened oats it is advisable to cover the taste of the strychnine with a liberal coating of sugar in this way.

Allow the oats to stand for two hours before laying. In laying the poisoned oats one teaspoonful is sufficient every 4 or 5 yards. The furrows used for feeding purposes will also do for the poison.

Strychnine and Pollard.—Recipe No. 1: Pollard 15 lb., flour 3 lb., molasses 3 lb., strychnine 1 oz., water (about) 13 pints. Boil the water and while still hot add the strychnine, then add the molasses. Stir till completely dissolved, then gradually add the pollard to the liquid; this should produce a stiff dough, which roll out and cut into cubes in the ordinary way, and dust well with dry pollard. The mixture is then ready for laying out in the same way as phosphorized-pollard poison. Free-feeding with sweetened pollard cubes for two or three days before laying the poisoned baits is advised.

Recipe No. 2: Water (hot) 2½ pints, molasses 2½ pints, strychnine 1 oz. Mix together, then stir in pollard until a stiff dough is produced, which is then rolled out and cut into cubes in similar manner to recipe No. 1. Free-feeding with sweetened pollard cubes is also carried out for two or three days before laying the poisoned baits.

In each case free-feeding baits should be gathered up before the poisoned cubes are laid, and if any poisoned cubes remain after the lapse of two or three days it is advisable to gather up and bury them.

Strychnined Jam Poison.—A suitable jam poison may be made by adding 1 oz. strychnine powder to 12 lb. quince, apple, or apple and raspberry jam. Stir the jam thoroughly with a clean stick while slowly adding the strychnine, so that the poison is evenly distributed. This poison will give good results in dry hot weather. Lay on the clean surface of a freshly turned sod in afternoon and evening. A calm day is most suitable.

Some General Points.

Stock should be removed before laying the poison.

Phosphorus should always be kept in water, and, for greater safety, away from buildings. Bisulphide of carbon should be securely corked, and stored in a cool place, as the fumes are dangerous if inhaled.

Carcasses of rabbits poisoned with strychnine should be carefully collected and buried.

Special care should be taken that all utensils used in the preparation of the poisons are perfectly cleaned, and personal cleanliness should be observed and the baits handled as little as possible. It is held by some that the addition of a small quantity of oil of aniseed to the poison immediately before laying is of advantage in attracting rabbits to the bait, and also in destroying all traces of human handling.

The strychnine should be ground as fine as possible, no grittiness to be observable. As strychnine is highly poisonous, the hands require to be thoroughly washed after the poison has been handled.

Scheme of Work.

The rabbit pest is not difficult to control if the proper methods are employed in the correct sequence at the right seasons. This has been proved conclusively by the results invariably obtained by Rabbit Boards. In many very badly infested districts, where individual haphazard methods had completely failed to control the pest, Rabbit Boards have been formed, and by reason of combined effort and systematic application of practical methods a measure of success far beyond the most optimistic expectations has been obtained. In two or three seasons the pest has practically disappeared, amply demonstrating the value of concerted action on sound progressive lines.

The most effective and economical scheme of work for the year may be briefly summarized as follows: Start in early autumn as soon as conditions are suitable by making a close general poisoning. Follow with other kinds of poison at intervals of three or four weeks as may be necessary, destroy cover, close all burrows, and gas any that are reopened. For spring and early summer work use traps, dogs, or gun to clean up stragglers, dig out nests, or destroy with carbon bisulphide or cyanogas. Apply all the pressure possible during the earlier months of the breeding season. If satisfactory work has been continued to December the work on rough country may now be suspended in order that any rabbits left may colonize and settle down in the more favoured and accessible spots, suitable for the next general poisoning in early autumn, when the procedure outlined should be repeated during the following season. If the work is thus carried out methodically a definite improvement should be noticeable at the end of the first year's working. Each succeeding season should show further improvement, and at the end of the third season the pest should be reduced to a point where it may be held with a minimum of effort and expenditure.

In cases where a special rabbiting staff is employed on the work of destruction, the question may arise as to how such staff can be profitably employed during what may be termed the off period—December to February. Work may be profitably continued on the more lightly infested blocks or areas, where the progress already made may be consolidated and finalized by the complete eradication of the pest and the destruction of cover and warrens as far as is

possible, thus reducing each year the area of infested country. This consolidating effort need not be extended to a greater area than can be completely cleaned up in the time available, after which the general programme of work should be again resumed.

Work to schedule and results will follow, but spasmodic efforts without regard to time or method will result in failure, disappointment, and waste. On the smaller holdings of clear grasslands, where the only cover is burrows, there is no reason why all rabbits should not be exterminated on one year's working with carbon bisulphide or cyanogas.

Working on these lines, very few skins or marketable carcasses will be recovered, but permanent progress will be made. If methods most suitable for the collection of skins and carcasses are adopted, the rabbit will continue to flourish. Which is of greater value, six rabbits or one sheep, thirty rabbits or one cow? A carrying-capacity of ten rabbits per acre would not appeal to a prospective buyer or be regarded as good security for a loan. Destroy the pest and increase production and the value of the holding.

Formation of Rabbit Boards.

(1) Persons wishing to form a Rabbit Board should call a meeting or meetings of ratepayers in the proposed district, at which the proposal may be discussed. The method of rating to be adopted should be decided and a boundary agreed upon.

(2) A small committee should be appointed to promote the petition and obtain signatures. Appoint a secretary.

(3) Prepare plan of proposed district, a copy of which should be attached to each copy of the petition.

(4) The boundary of the district to be embodied in the petition should be certified correct by the Lands and Survey Department before the petition is circulated for signatures.

(5) When the requisite number of signatures have been obtained the petition should be forwarded to the Minister of Agriculture, through the Director-General, Department of Agriculture, Wellington, for presentation to the Governor-General.

(6) When forwarding the petition the committee should recommend a fit person to act as first returning officer, who will subsequently be required to indicate a suitable date for the first election of members.

(7) The first returning officer will hold the first election of members and thereafter convene the first meeting of the newly elected Board.

(8) At the first meeting of a new Board the returning officer reads the *Gazette* notice constituting the district and the published result of the first election. He then requests the members to elect a chairman.

(9) The elected chairman then assumes control of the meeting, which proceeds to appoint a secretary and treasurer. The first returning officer then hands over to the secretary appointed.

(10) The Board decides the bank with which an account shall be opened, the date of regular meetings, &c.

FORM OF PETITION FOR FORMATION OF BOARD.

To His Excellency the Governor-General of the Dominion of New Zealand.

THIS humble petition of the undersigned ratepayers of the lands hereinafter described showeth—

1. That the land hereinafter described is not less than 20,000 acres in area and that there are not less than ten ratepayers within the said area.
2. That your petitioners form a majority of the ratepayers within the said area.
3. That the said area comprises all that parcel of land, delineated on the plan attached, and described, commencing at [*Complete description of boundaries of district here or in schedule to be attached.*]
4. That your petitioners are desirous that within the said area a Board be constituted and declared within the meaning of Part II of the Rabbit Nuisance Act, 1928.
5. That it is the intention of your petitioners to rate on the basis of the acreage of land occupied by the ratepayer [*Or as the case may be*].

And your petitioners will ever pray, &c., &c.

Ratepayer's Signature.	Signature of Witness.
	[*One ordinary signature. Initial rest.*]
.....	.....
.....	.....
.....	.....

FORM OF DECLARATION TO BE MADE BY WITNESS TO SIGNATURE OF PETITION.

I, , do solemnly and sincerely declare that the signatures to the petition to form Rabbit District and initialled by me are the genuine signatures of the persons whose signatures they purport to be, and I make this solemn declaration conscientiously believing the same to be true and by virtue of the Justices of the Peace Act, 1927.

Signature : .....

Witness : .....

Justice of the Peace.

DECLARATION BY COUNTY CLERK.

I, , do solemnly and sincerely declare that—

1. I am Clerk to the County of .
2. That the persons whose signatures are appended to the within-written petition to form Rabbit District comprise a majority of the ratepayers of the area mentioned in the petition (so far as such area is within this county), and I certify that within the area described there are ratepayers (rated in respect of 10 acres or more) of whom have signed the petition.

Signature : .....

County Clerk.

Witness : .....

Justice of the Peace.

CERTIFICATE BY CHIEF SURVEYOR, LANDS AND SURVEY DEPARTMENT.

I hereby certify that I have examined the plan initialled by me of proposed Rabbit District, and that the schedule to the petition correctly describes the area delineated on the said plan.

Signature : .....

Chief Surveyor, Department of Lands and Survey.

WILT DISEASES OF TOMATOES DUE TO *FUSARIUM LYCOPERSICI* AND *VERTICILLIUM ALBO-ATRUM.*

THEIR APPEARANCE, CAUSE, AND PREVENTIVE TREATMENT.

E. E. CHAMBERLAIN, Mycological Laboratory, Plant Research Station, Palmerston North.

Two wilt diseases of tomatoes are prevalent in New Zealand, and cause considerable annual loss to growers. Although their symptoms are very similar and the same preventive treatment may be applied to both, their incidence is different, and they are caused by two distinct organisms, *Fusarium lycopersici* and *Verticillium albo-atrum*. In other countries tomato-wilt has been known as "sleepy disease," a name which has been applied to fusarium-wilt in America and to verticillium-wilt in England.

Fusarium-wilt.

Fusarium-wilt, first recorded as occurring in New Zealand by Kirk in 1906, is one of the commonest diseases among glasshouse-grown tomatoes, and occurs to a lesser extent out of doors. It is considered to be one of the most serious diseases of tomatoes in North America, and has been recorded in addition from England and Australia. Both in this and other countries the disease is confined to tomatoes.

SYMPTOMS.

Fusarium-wilt usually makes its appearance when the plants are in the three to five truss stage, although on rare occasions it may appear earlier. The disease first becomes apparent as a slight wilting of the leaves. This wilting, which becomes more pronounced so that at the end of the third or fourth day the plants have collapsed, is followed by withering of the leaves and death of the plants.

The roots are also attacked, and an examination of the wilted plants shows that the small roots have rotted away, while cankers have formed on the larger roots and underground portions of the stems. By cutting transversely through the stems the vascular bundles are shown to be discoloured dark brown. This discoloration is confined to the bundles, and as a rule occurs only in the lower portions of the stems.

ECONOMIC IMPORTANCE.

This disease, which is prevalent throughout New Zealand, is particularly troublesome in glasshouses. Infections of up to 50 per cent. have been recorded both from the glasshouse and the field, but while this is not uncommon in the former, where the plants have not been grown in sterilized soil, it is an unusually high infection for outdoor-grown tomatoes.

If the plants become infected before they come into bearing, as often happens, the plants are a total loss, but if infection does not occur until late in the season the loss may be slight.

Life History of the Causal Organism.

Elsewhere the causal organism has been shown to be *Fusarium lycopersici* Sacc. (Bewley, 1922), and this has been verified by inoculation experiments with New Zealand material.

The life history of the organism has been outlined by McCubbin (1918) and Bewley (1923). The fungus is typically a soil organism, and infection always takes place from the soil. It lives as a saprophyte on organic matter in the soil, and is capable of attacking and entering the roots of any tomato plant with which it comes

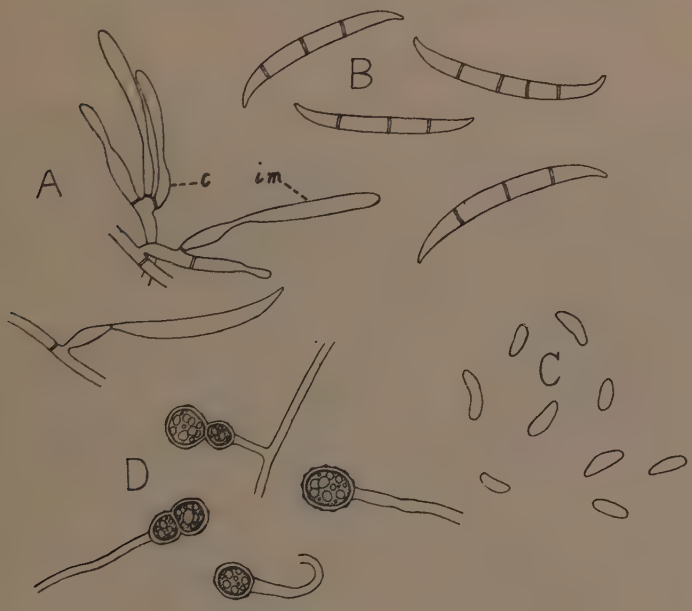

FIG. 1. SPORES OF FUSARIUM LYCOPERSICI. × 730.

A. Formation of macroconidia; (*im*) immature conidia, (*c*) conidiophores. B. Mature macroconidia. C. Microconidia. D. Chlamydospores.

[*Original.*

in contact. It spreads over the roots, causing the small ones to rot away and forming cankers on the larger ones. In some cases the whole root system may be destroyed. Having gained entrance through the roots, the fungus travels up the stem by way of the vascular bundles, to which, in the stem, it confines its attack. The death of the plant appears to be due to a combination of several factors—destruction of the root system, blockage of the water-carrying vessels in the vascular bundles by the fungus hyphæ, and the secretion of toxins.

When the plant dies the fungus is able to spread from the vascular bundles and penetrates into all dead tissues. At the base of the plant the mycelium of the fungus often grows out on to the surface of the stem, and aggregates to form masses of interwoven

hyphæ (stromata). From these arise the fertile hyphæ or conidiophores which bear the spores (conidia). These spores are of two types, the one being small and non-septate, and the other long and several septate (Fig. 1). They are carried by the wind, and so may be spread through the glasshouse or garden or even carried to neighbouring gardens. Under suitable conditions of humidity and temperature the spores germinate and the fungus spreads into the soil.

Besides the spores already referred to, the fungus develops resting spores or chlamydospores. These are rounded, thick-walled spores formed as swellings on the hyphæ (Fig. 1, D), and it is by means of these that the fungus overwinters in the soil.

Factors affecting Infection, Growth, and Spread of Fusarium-wilt.

The disease occurs only at fairly high temperatures and rarely appears at temperatures below 72° F., while it is most severe at 82° to 83° (Clayton, 1923A). This explains why it is that under New Zealand conditions the disease is of greater significance under glass than in the field. The work of Clayton (1923B) has shown that plants growing under optimum moisture conditions for growth are most susceptible to the disease. Plants growing in soil with a low moisture content or in saturated soil resist the attack of the fungus.

Although infection rarely takes place at the seedling stage, infected soil removed with the plants may spread the disease to clean ground. It may be carried from one portion of a garden to another by soil adhering to implements or boots. Fusarium-wilt may also be disseminated by spores produced by the fungus occurring on the remains of infected plants which have been allowed to remain in rubbish heaps in or near the garden.

It has been shown by Edgerton (1918) that the fungus spreads more rapidly in sterilized than it does in unsterilized soil. The work of Elliott and Crawford (1922) has shown that in America the fungus penetrates to the fruit and that fusarium-wilt may be carried in the seed. In this country infection of the fruit has not been observed, and there is no evidence to show that the disease is seed-carried.

Different varieties of tomatoes show a great deal of variation in their resistance to the attack of the disease (Shapovalov and Lesley, 1924). In America a great number of resistant varieties have been evolved, and in the southern United States, where the disease is prevalent in the field, the growing of such varieties is considered to be the only practicable method of control.

Verticillium-wilt.

In this country verticillium-wilt is not so prevalent as fusarium-wilt, but it may cause serious damage to both glasshouse and outdoor tomatoes. It was first recorded in New Zealand by Taylor in 1924. Unlike fusarium-wilt, it has been recorded as attacking a very wide range of hosts (Rudolph, 1928), although in New Zealand it is only known to attack tomatoes and potatoes.

Symptoms.

The first symptoms of verticillium-wilt are similar to those of fusarium-wilt. The disease does not as a rule appear until the plants are in the three to five truss stage, and complete collapse of the plant usually occurs within three or four days of the initial wilting (Fig. 2). During the first few days of the attack the plants may, during the night, partially recover from the wilt. It is quite common to see one side of the plant wilted, while the other side is quite normal, but within a few days the whole plant is affected. Once the plant has collapsed the leaves soon turn brown and the plant dies.

FIG. 2. VERTICILLIUM-WILT.

Comparison of healthy and infected plants of the same age. The plants are of the Australian Dwarf variety.

In the Nelson district, where the disease has been locally known as "brown top," the symptoms appear to be slightly different. The top of the plant, which is affected first, sometimes turns a silvery-purple colour, and this is followed by the usual wilting and death.

On cutting transversely through the stem of the plant, the vascular bundles are seen to be discoloured. The discoloration, which is confined to these tissues, is somewhat different to that caused by fusarium-wilt, being a lighter brown in colour, and extending as a rule to the top of the plant. Verticillium-wilt is typically a stem disease, and, unlike fusarium-wilt, it does not cause a rot of the roots. These differences afford a method whereby the two diseases may be separated in the field.

Economic Importance.

The disease is prevalent throughout New Zealand. During last season it occurred on glasshouse tomatoes in the Auckland district, and also caused considerable damage to a number of field crops at Gisborne, where in one garden 80 per cent. of infection was recorded. It has also been reported to sometimes cause fairly severe losses of plants in the Nelson district. When the plants become infected before they come into bearing, they do not yield any fruit.

Life History of the Causal Organism.

In other countries the organism responsible for this disease has been shown to be *Verticillium albo-atrum* R. and B. (Bewley, 1922). This has been confirmed by experiments conducted in this Laboratory in which the fungus has been isolated from wilted plants, and its pathogenicity tested by inoculating it into healthy plants. Inoculation experiments have shown that verticillium-wilts attacking tomatoes and potatoes are the same.

The life history of the organism has been described by Bewley (1922) and Rudolph (1931). As is the case with fusarium-wilt, this fungus is typically a soil organism, and infection can only take place through the soil. It is able to enter the uninjured roots and grow up through the vascular bundles into the stem, where it cuts off the supply of water to the leaves by blocking the vessels, and thus brings about a wilting of the plant. During the early stages of infection the fungus confines its attack to the vascular bundles, but when the plant dies it spreads through all the tissues. Under favourable conditions it grows out to the surface of the dead plant, usually at the base, where it forms a white mycelium, from which arise the conidiophores or fruiting branches. Arranged in whorls on the main axis of each conidiophore are short branches or verticils which bear small spores (conidia) at their tips (Fig. 3). These spores may be carried by the wind to uninfected soil, where, under favourable conditions of humidity and temperature, they germinate and produce a mycelium.

As the fungus becomes older or the growing conditions become unfavourable it develops a resting mycelium which is able to withstand adverse conditions and to overwinter in the soil. This resting mycelium is composed of thick-walled, darkened, much-septate hyphæ, and of chlamydospores which are also thick-walled, dark, and formed as swellings on the hyphæ (Fig. 4). Under favourable conditions in the spring the thickened hyphæ and chlamydospores germinate and grow out into the surrounding soil.

Factors affecting Infection, Growth, and Spread of Verticillium-wilt.

The disease develops at comparatively low temperatures — 60° to 75° F.—and is most active at 72° to 73° F. (Bewley, 1922). At temperatures of 77° F. or over the fungus is unable to grow, and infected plants removed to such temperatures recover from the wilting. If the plants are kept at a high temperature they will produce a crop, but if the temperature is lowered the plants again

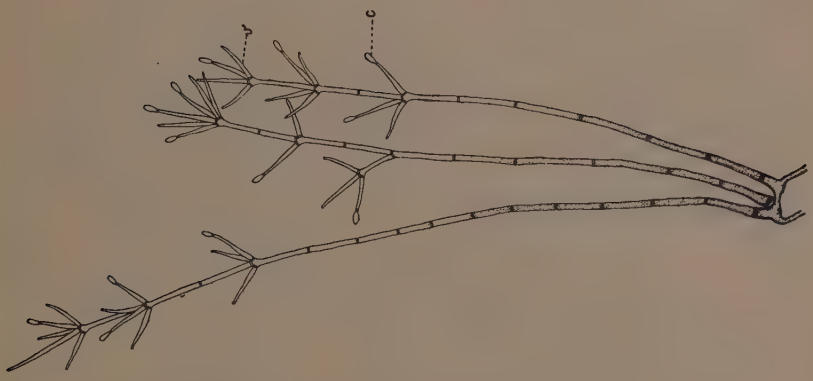

FIG. 3. VERTICILLATE CONIDIOPHORES OF VERTICILLIUM ALBO-ATRUM. × 270.
(*v*) Verticils; (*c*) conidia.
[*Original.*

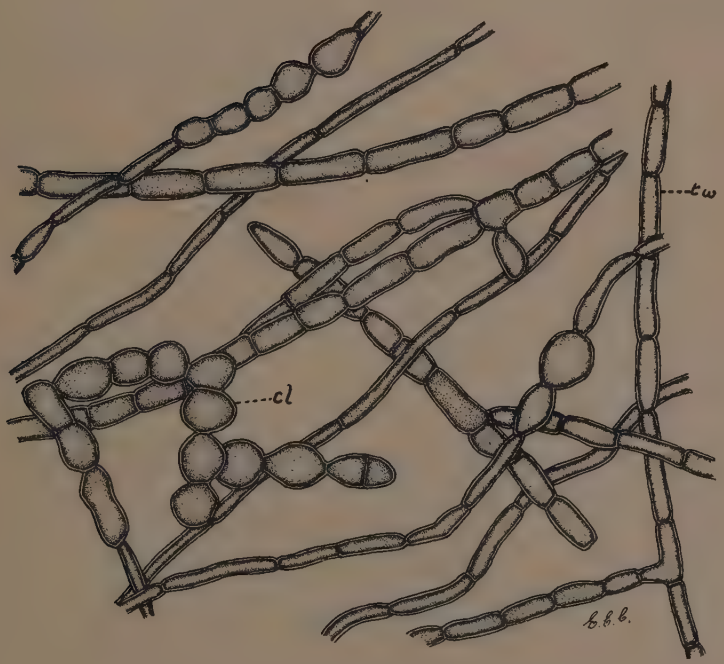

FIG. 4. RESTING MYCELIUM OF VERTICILLIUM ALBO-ATRUM. × 825.
(*tw*) Thick-walled hyphæ; (*cl*) chlamydospores.
[*Original.*

wilt and ultimately die. During the early stages of the attack, before the wilting has become severe, any reduction in transpiration helps the plants to recover. This accounts for the partial recovery of infected plants overnight.

Verticillium-wilt is prevalent on potatoes, and on this host is carried in the tubers. From the plants which have become infected through the tubers the fungus is able to grow out into the surrounding soil, and in this way the soil of many gardens has become infected. As with fusarium-wilt, the disease may be spread by infected soil adhering to the roots of seedlings. The fungus spreads more rapidly in sterilized than in unsterilized soil (Bewley, 1922). Any check to the plants during the growing season appears to make them more susceptible to the disease. Excessive water at the roots of the plants aggravates the wilt. Although some varieties have been recorded as showing resistance to the disease (Bewley, 1922), no variety in which high yields and good-quality fruit are combined with resistance has yet been produced.

Preventive Measures in the Control of Tomato Wilts.

Although in other countries tomato varieties resistant to fusarium-wilt and verticillium-wilt have been produced, none of the varieties grown in New Zealand has been tested for resistance to either of these diseases. No practicable soil treatment for use in the field has been evolved, for, although the fungi may be killed with formalin, it is too expensive and too difficult of application for use on large areas. An attempt was made by Robbins (1926) to control fusarium-wilt by liming. Water-slaked lime at the rate of $2\frac{1}{2}$ to $3\frac{1}{2}$ tons per acre was found, when thoroughly incorporated into the first 9 in. of the soil, to give partial control, but the results were not entirely satisfactory. Ordinary fungicidal sprays such as bordeaux, &c., are quite useless as controllants of these diseases.

Control in the Field.

For the control of these diseases in the field it is recommended that growers act as follows:—

(1) Avoid growing tomatoes in land which has been in potatoes during the past two to three years.

(2) Raise all their own seedlings in either steam-sterilized or formalin-disinfected soil.

(3) Take care that the plants receive as little check in growth as possible, especially during transplanting.

(4) Where only a few plants become infected, remove and destroy them by burning.

(5) Where wilt becomes general, cultivate thoroughly and mould the earth up at the base of the plants to encourage the formation of new roots.

(6) Where artificial watering is practised, avoid excessive watering at the roots.

(7) At the end of the season destroy all stalks and roots by burning.

Control in the Glasshouse.

For control of the diseases under glass the following recommendations are made, in addition to those already listed in connection with control in the field :—

(1) Sterilize the soil of the glasshouse by either steam-sterilization or formalin-disinfection.

(2) When resoiling the glasshouse use sods (lifted and allowed to break down over winter), preferably from a field which has been down in grass for a number of years.

(3) Where wilt is general throughout the crop but fusarium-wilt alone is responsible, reduce the temperature to as much below 80° F. as is consistent with good growth of the plants.

(4) Where only verticillium-wilt is present, increase the temperature to as much above 77° F. as possible.

(5) With verticillium-wilt, give the leaves a light spraying with water and whitewash the glass to reduce transpiration, thus hastening the recovery of the plants.

Note.—Formalin disinfection is carried out by saturating the soil with formalin at the strength of 1 gallon commercial formalin to 50 gallons water. In treating soil such as in the glasshouse, 2 to 3 gallons of solution per square yard are usually required to saturate it. Cover the soil with damp sacks for twenty-four hours after treatment, and after removing them allow the soil to remain for two weeks so that all the formalin vapour has disappeared before the seed is sown or the seedlings planted.

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A NEW ELECTRIC STEAM-STERILIZER FOR DAIRY PLANT AND UTENSILS.

Mr. W. Dempster, Dairy Instructor, Dairy Division, Hamilton, reported in December on the trial of a new electric steam-sterilizer which has been invented by Mr. J. R. Ellis, engineer to the Waikato Central Power Board. He gives the following particulars of the apparatus :—

In addition to the ordinary container for boiling water, there is an insulated box which contains an element and will generate and store heat. A thermometer in this box was registering heat at 650° F. at the time of the trial. This steam heat when directed into the milk-pipe of a milking-machine was sufficient to show heat at the farther end of the pipe at a temperature of 210° in approximately fifteen seconds. The heating of the pipe could be said to be almost instantaneous, as no sooner was the cock turned on than steam was issuing from the downpipes and teat-cups. The reduction of temperature in the heating-box was approximately 200° while the machine was being sterilized. This 200° can be generated again in approximately five hours, so that it is possible to sterilize a machine twice daily.

The installation of the trial apparatus was arranged so that all the heating was done when not on the peak load. The switch is so arranged that when the milking-machine is stopped the current is automatically connected with the water-heater and heat-generating box, so that there is every inducement for a farmer to sterilize his plant, as the steam will be generated without extra effort on his part.

The first cost of the container and elements, together with the heat-storing box, will be approximately £15, and the cost per year will be in the vicinity of £7. Mr. Ellis is conducting further experiments in an endeavour to find out the most suitable lagging material for the apparatus, also with the object of lessening the annual cost to farmers.

A POTENTIAL DANGER TO COWS IN DAIRY WASHINGS.

Now that the hot months of summer have arrived and stock are apt to become extremely thirsty, it is desirable to warn dairy-farmers that when they clean out their milking machinery and cans with caustic soda, carbonate of soda, or any proprietary alkaline cleanser, cows should on no account be allowed to drink the washings, which are often run down an open drain. Valuable stock have been lost at two or three farms under conditions which suggest that some caustic agent was ingested, the stomach and intestines being inflamed, and no common poison such as lead or arsenic being found. Farming papers would do well to further circulate this warning.—*B. C. Aston, Chief Chemist, Department of Agriculture.*

Silver-leaf in Apricot-trees.—The Orchard Instructor, Dunedin, states that when silver-leaf (silver-blight) appears in young bearing apricot-trees it is common practice to suspend pruning and thinning operations for several seasons. He has seen a number of trees gradually recover under this treatment.

SEASONAL NOTES.

THE FARM.

Pasture Management in Summer.

ONE of the most important general objectives of pasture management in summer should be the avoidance as far as possible of growth of that stemmy character which results from the development of flower-stalks. The development of flowering parts in pasture plants not only leads to a substantial decrease in the nutritive value or quality of the feed yielded by them, but also initiates a considerable decline in the rate of growth. It is natural for the plants which have flowered and matured to assume a quiescent condition for a period, during which supplies of fresh leafy feed may become harmfully scant.

While it cannot be laid down that the complete avoidance of stemmy growth of pastures is always practicable or even desirable, it is certain that, especially from mid-summer until early autumn, many pastures are allowed to become more stemmy than is consistent with the maximum net returns from them. Farmers who are faced with the prospect of such pastures may at times, with distinct advantage, carry out mowing in February or thereabouts in a manner which will remove or "top" the portions of the sward which are rank and producing seed, in order to stimulate the production of fresh leafy growth from the base of the topped plants. Mowing at the season mentioned may also serve usefully to remove shade-creating parts of such weeds as thistles, docks, fat-hen, and red-shank (willow-weed) which at times overrun pastures. The shading caused by such weeds is likely to weaken greatly the pasture plants in their vicinity, and possibly eventually create vacant patches on which subsequently inferior plants may become established.

Preparation for Autumn Sowing of Pasture.

An important summer task on many farms is the preparation of ground for the autumn sowing of pastures. At times those carrying out such work seem to appreciate very imperfectly the value of the thorough preparatory cultivation needed to ensure a fine firm seed-bed. Some evidence of the value of firmness in the seed-beds for pasture seed mixtures is provided in the fact that the best pastures often occur round the headlands or along tracks where there has been the greatest amount of consolidation by the passage of stock and of machinery. Consideration of the relatively small size of the seeds of certain important species of pasture plants should serve readily to make it clear that in lumpy ground a proportion of such seeds is likely to be buried so deeply as to be unable to reach the surface with their shoots, should they germinate.

In districts where the ravages of the grass-grub have been prominent during recent seasons it is advisable to avoid the sowing-down of pasture in land which in the immediate past has been occupied by a cereal or by grass. On the other hand, the more land was bare of a covering of plants in the period from November to January, during which the eggs that develop into the grass grub are deposited in large numbers, the more likely is the land to be free from the grub in the following twelve months.

Autumn Top-dressing.

Some of the grassland on many farms may well be dressed with phosphates in February or a little later. When the amount of moisture in the soil is sufficient to admit of active growth provided the supply of plant-food material is ample, then the application of phosphates at the

stage mentioned is likely to increase the production of fresh growth from shortly after the phosphates are distributed until well into the winter, and thereby strengthen the feed position not only for the latter portion of the current season, but also for the coming winter and spring. In addition, the stimulating influence of phosphates, including superphosphate, so applied will continue during the following spring and summer, but will not then be so intense as if the phosphates were applied in winter or early spring. In brief, application of phosphates in the autumn ordinarily tends to a more even rate of growth of grass throughout the year, and this assists in minimizing the critical seasons which are characterized by scant supplies of feed and which are the prime cause of much of the inefficient feeding of stock that occurs.

Certified Seed for Pasture Establishment.

As a result of the official system of certification dependable supplies of genuine perennial rye-grass are now commercially available to those who purchase "certified" seed. The marked superiority for all swards, except temporary ones, of true perennial rye-grass over other types which have at times been confused with it has been so widely and completely demonstrated that farmers generally do not now question its intrinsic merit. But up to the present time the use of certified rye-grass seed necessarily has been restricted. The position has been that of a meritorious practice in its infancy—a limited production of certified seed has been readily marketed at a comparatively high price, and put into use with results so satisfactory that the demand for certified seed has increased continuously from the outset. The infancy stage of the use of certified rye-grass in our farming seems to be approaching its end. The crop of certified seed which is now being harvested and which will be available for autumn sowing so greatly exceeds any previous crop that a substantial fall in price of all grades of certified seed is assured.

Thus for the coming season of pasture establishment no farmer will be justified in stating that he is convinced of the comparative superiority of certified seed, but is deterred from using it because its cost is beyond his means. It seems likely that certified rye-grass seed of "Permanent Pasture" grade (the grade which is quite suitable for use by all farmers except those who contemplate harvesting certified seed, in the future, from the area to be sown) will be obtainable this season at a price as low as that of good average uncertified seed in recent years. There was a possibility, but no assurance, that such uncertified seed inherited good type, whereas attaching to the certified seed is the official assurance that it is true perennial rye-grass. In short, for the farmer needing true perennial rye-grass reliable supplies promise to be available under the official system of certification in considerable quantities at normal prices. Seed of "Mother" standard should be used by any farmers who plan the future production of certified seed. From such mother seed sown in the approaching autumn it is ordinarily possible to harvest a crop of seed eligible for certification in the following summer.

In the purchase of certified seed the purity and germination capacity of the lines offered should always be taken into account, for in respect to these two important matters there is absolutely no guarantee, and indeed little likelihood, of uniformity in lines of certified seed. Hence lines which seem to be unduly costly may in reality be relatively cheap when due weight is given to their comparatively good germination and purity.

In pasture establishment what would have been accepted as sound practice a few years ago would not always now be ranked as fully efficient. The matter of seed-mixtures for permanent pastures is an important instance of this. Information about mixtures and other phases of pasture establishment can be obtained most readily and fully by applying to district officers of the Fields Division.

Feeding Difficulties in February.

It is customary for February to be characterized by scant supplies of the leafy feed needed to assure the maintenance of dairy production at the rate which would yield the maximum profits. And this season in several districts because of recent dry weather it seems that the February shortage of productive feed will be more acute than usual. It frequently cannot be said that an unduly rapid falling off in dairy production after midsummer is due to a shortage of feed, for there is obviously plenty of feed of a kind which keeps the stock in good condition. But the feed that is in plenty is not productive feed; it is too mature, and so lacking in qualities required to permit of heavy milk-production that although the stock may consume it freely, they still experience a deficiency of some of the substances required for milk-production. This is likely to happen if stemmy grass or silage made from growth that approached maturity figures prominently in the rations. It is also likely to happen if mature maize or woody lucerne is being fed as green feed to supplement pastures which themselves incline to be stemmy, as is often the case after midsummer.

In practice, an important means of avoiding an unduly rapid falling-off in production at this season is the keeping of the pastures relatively short and leafy. But if the ground is dry the production of leafy feed will dwindle, even though the grazing management and utilization of the grassland is as efficient as possible. Hence in dry conditions aid must be sought in other directions, such as the feeding of young succulent lucerne or red clover, soft turnips, young millet, or silage made from immature growth.

During February a supply of succulent feed is of considerable value for feeding to ewes for about a week or ten days before the rams are put out with them. Suitable succulent feed may be provided by rape after its first feeding-off by lambs, or it may be obtained from the best available short pastures. At this season ewes which give indication of excessive condition should be kept on short rations long enough to reduce their weight appropriately.

Conservation of Soil Moisture.

In all but the wetter districts of the Dominion a common cause of limited crop-yields is an inadequate supply of soil moisture during the latter part of summer. If land under the plough is occupied by crops sown in rows wide enough apart to allow of summer cultivation, then surface tillage carried out frequently enough to maintain the top layer of soil in a loose condition is of great value in checking loss of moisture by direct evaporation from the surface. Hence surface tillage which loosens a surface that has become caked as the result of a heavy or beating rain is, independently altogether of its effect upon weeds, likely to be of distinct benefit to such crops as mangels and potatoes which are not advanced enough to shade the soil between the rows. The loose surface layer which conserves the moisture for the use of crops is termed a soil mulch.

In pastures, an effective soil mulch being an impossibility, it becomes advisable to depend upon a plant mulch, which is provided by keeping the plant covering of the land as unbroken as possible. To do this means that the pastures should not be grazed so closely during the dry season that portions of the surface are exposed to the direct drying effect of winds and sun. Hence during the dry summer period pastures should be left as long as possible consistent with reasonable grazing control. From this it is not to be inferred that stemminess must be allowed to become prominent. Really it is leafy growth rather than stemmy growth which most effectively reduces loss of moisture by direct evaporation from the surface soils. Hence, in endeavouring to reduce loss of moisture by

evaporation, there is no need to neglect the proper grazing control of the grass growth. There is a happy medium in the closeness of grazing between the hard eating-down of growth which exposes the surface of the land to sun and wind and the light browsing which inevitably leads to the development of stemmy flowering organs. In their endeavours to avoid undue drying-out of pastures many allow the grass growth in summer to become far too long, and thereby probably cause more harm than would have been caused by close grazing.

Work with Special Crops.

The sowing of catch-crops in late summer is at times well worth consideration. For instance, land from which a cereal crop has recently been harvested, if sown without delay in Italian or Western Wolths rye-grass (25 lb. to 30 lb. an acre) and red clover (5 lb. to 6 lb. an acre) will provide autumn and winter feed that is very likely to be distinctly useful, especially to sheep-farmers under Canterbury or similar conditions. Black Skinless barley sown at the rate of 2½ bushels an acre for earliest possible use, and Algerian oats for later use, may also be sown for the production of green feed after a cereal or after an early crop of soft turnips. In many districts suitable varieties of turnips such as Imperial and Hardy Green Globe may still be sown with reasonable prospects of satisfactory results. With all the crops just mentioned profitable results may be expected from the use of a dressing of 1 cwt. to 2 cwt. of superphosphate per acre.

Young lucerne which was sown in November or December is often fit for mowing in February. Such mowing should not take place until flowering has commenced, unless weeds are tending to weaken the lucerne plants by their shading effect. Mowing prior to flowering checks the development of the root system, and sturdiness and heavy yield of the lucerne crop is associated with an extensive root-system.

It is usually profitable to top-dress lucerne with phosphates in summer. The benefit of such top-dressing is, for some time at least, received almost exclusively by the lucerne, whereas the benefit of spring top-dressing is at times shared by the lucerne with invading plants, such as rye-grass and cocksfoot, which in the interest of the lucerne it is desirable to suppress.

If arable land is known to be infested with the seeds of annual weeds such as fathen, spurrey, and nightshade, which germinate in the spring or early summer rather than at other seasons, then the cropping of such land should be planned so that it will be sown in the autumn. The autumn-sown crop is likely to become established without competition from such weeds, whereas a spring-sown crop is likely to be stunted by strong competition from them from the outset.

In the latter part of summer there is often need to destroy, in such crops as potatoes, mangels, and carrots, a secondary invasion of weeds which develop after the main invasion of weeds has been destroyed. Only by dealing effectively with this secondary invasion will such crops be made "cleaning" crops in fact as well as in theory.

—R. P. Connell, Fields Division, Palmerston North.

THE ORCHARD.

Maturity in Pip Fruits.

SEVERAL methods have been introduced to assist the orchardist in arriving at the best stage of maturity for picking pip fruits—notably the iodine and the pressure tests. Unfortunately, varietal differences of response to the iodine test, and the degree of pressure change, particularly in pears, have given irregular results. Several factors appear to influence the position,

notably the question of the position of the individual flower of the bud from which the fruit developed, whether terminal or lateral, or the possible influence due to the particular form of culture in operation.

Until such time as a more reliable form of determination of maturity for local or export marketing requirements obtains, the older forms of indication must suffice—namely, colour, ease of release from the tree, and pip-change indications. It would appear that the change from leaf-green base to the slight yellowing tinge, combined with the ease of relief from the cluster attachment, is the most reliable indication at present.

Harvesting.

Every endeavour of the grower should be directed at harvest-time to obviate adverse conditions as far as possible. In no respect can this be accomplished more effectively at present than by employing pickers of experience who have a knowledge of the requirements, handle the fruit carefully, and follow the instructions given to them.

There has been a noticeable improvement in the get-up of stone fruits in the past few years. It may, however, be remarked that there is a tendency to market certain varieties prematurely, and it might be advantageous to the producers concerned to come to some marketing arrangement whereby a slightly greater degree of maturity might be aimed at. It is understood, of course, that situation and environment enter into this question.

Reports received last year of overseas consignments arriving at their destination in a bruised condition imply the necessity for greater care in picking, handling, and carting to the packing-sheds. A strict supervision of these operations appears to be necessary. It is poor recompense after the expense incurred in producing a clean crop if it be nullified by any degree of carelessness.

Fireblight.

A sharp look-out for twig infection should be kept, where blossom infection was experienced. It is usually from these sappy growths that ooze develops, and their cutting out and destruction helps materially towards preventing subsequent extension of the trouble. Care must be observed in keeping the pruning shears sterilized, nor should the cut surfaces be overlooked in this respect.

Budding.

When weather conditions are suitable and little difficulty is experienced in lifting the bark, budding may be proceeded with. Provision will have been made for budding wood where grafts have missed. This work is important if an evenly balanced tree is to be attained, and on that account should have precedence over other budding operations.

—H. F. Frost, Orchard Instructor, Wanganui.

Citrus Culture.

Work for the coming month will consist mainly of maintaining a clean state of cultivation, with the surface soil constantly worked to keep a depth of 3 in. or 4 in. of earth mulch. Continued cultivation is the first essential to conserve moisture. The destruction of weeds is also very necessary, as much moisture escapes from the soil through these growths. Wherever rough litter, such as hay, straw, or stable manure is available, this should be spread over the surface of the rooting area, to form a mulch, affording protection against evaporation and maintaining a more equable soil temperature.

Irrigation is not necessary as a rule in citrus groves, but there are occasions when it could be used to advantage. Citrus trees make their

greatest demand on the water content of the soil during the period of minimum rainfall, and satisfactory growth and development cannot take place when moisture is not available. It is worth considerable effort to supply water; the response will often save defoliation and loss of crop.

Harvest all fruits as soon as ready. Do not allow ripening fruits to develop on the tree and unduly tax it at this period of strain.

—L. Paynter, Orchard Instructor, Auckland.

POULTRY-KEEPING.

Points in Culling.

THE month of March is usually regarded as the best period of the year for going through a laying flock for the purpose of weeding out all birds that have passed their best period of production. It is then, or just before moulting commences, that certain signs manifest themselves which indicate in a striking manner whether a bird in the recent past has been a profitable producer, or whether it is likely to be so in the near future. During March the poultryman looks to the moulting stage as the chief sign by which the profitable can be distinguished from the unprofitable layers. He realizes that if a bird is to produce a maximum yield in eggs it must necessarily be a long-season layer and a late moulter, for it is only in exceptional cases that birds produce and undergo the moulting at the same time. The wise course, therefore, is to discard the early moulters and keep the late moulters.

The statement that March is the best month of the year for culling out unprofitable stock does not imply that it will pay to keep all birds from now on to the termination of their present laying period, for in most flocks, no matter how well the birds have been bred or fed, individuals are to be found that will not continue to be profitable. It is true that considerable caution must be exercised in the work of culling at this period of the year, for sometimes the heaviest layers have the most worn and shabby appearance, and are the thinnest birds in the flock, whereas the heaviest and best-looking birds are the drones. Especially does this apply to the former where the food is not supplied with a free hand or where it is of inferior quality.

The only guide to successful February culling is the appearance of the birds. The bird above the average weight of the breed and looking in the very pink of condition is very often the drone. The condition of the abdomen also serves as a good guide to laying capacity. In the good bird this will be found to be full, pliable, and soft to the touch. On the other hand, the abdomen of the low producer will be more or less shrunk, besides being thick and hard to the touch. The undesirable bird should not be confused, however, with the heavy layer which is easing off in egg production and is preparing for more production, and is thin and light for her size. At this period of the year it is often difficult to distinguish between the two classes of birds, but it may be taken as a good guide that the thinnest birds at this season of the year are the heaviest layers in the flock.

Other indications of poor laying-power are a well-kept plumage, and any signs of weak constitution, such as a dull sunken eye, loose feathering, sluggish appearance, and anything denoting unhealthy condition. In the case of the breeds with yellow legs, such as Leghorns, it will generally be found at this season of the year that those which have lost the deep yellow colour—the legs having become more or less white and bleached-looking—are the best layers and the strongest birds in the flock, whereas

those with legs of a rich yellow are the drones. It may be mentioned that the legs of even the best layers will not become bleached out to the same extent when a grass range is provided as when they are kept in confinement.

Here, as in all matters connected with the management of poultry, local conditions must be taken into account when applying this test. The same may be said with regard to taking the time of moulting as a guide to productive capacity. It will usually be found that in a mixed flock of first- and second-year layers the latter will, owing to their shorter season of production, moult later than in their pullet year. Therefore in the work of culling due allowance must be made for the age of the bird, as otherwise many of the young birds which it would be profitable to keep are apt to be disposed of, and their older but less profitable sisters retained in the flock.

The man who studies his birds closely, and thereby develops his powers of observation, should be able to detect at a glance the bird that is failing in egg production, a failing which as often as not is the result of a weak constitution.

How to make Inquiries.

Of the many inquiries received by the writer for advice on the treatment of birds affected with certain troubles, arising in the majority of cases out of improper management, it is only on rare occasions that the inquirers supply the information necessary for arriving at a definite opinion regarding the cause and nature of the trouble, much less for suggesting a remedy. Even where the inquirer has fully described the symptoms observed in regard to some trouble met with, and gives detailed advice relative to the food supplied, together with the general conditions under which the birds are being kept, it is often difficult to arrive at an opinion as to the nature of the trouble; but where the details concerning the flock are only partly set out the best the writer can do is to guess the probable cause, and likewise in regard to suggesting measures that are likely to have the desired effect.

For example, many inquiries are received regarding mortality in young chickens, but it is only in isolated cases that any intimation is given as to whether the young birds are being reared by the natural mother or by artificial means. Obviously, in view of the varied details of the two systems of rearing, it is practically impossible to give any advice at all. In the case of mortality in stock, every little warning symptom should be described, as well as details in regard to the methods of management, and especially the class of food supplied or any variation of this. It is particularly important to advise where condiments, tonics, or other patent foods, or even salt, are included in the ration.

Frequently inquiries are received regarding troubles met with in which no lead whatever is given which would enable any explanation of the difficulty to be given. In the circumstances the best that can be done is to ask that full particulars regarding the case be supplied, and if these come to hand clearly set out the cause of the trouble is usually made apparent. If, however, the necessary details are given in the first place the writer's time would be saved as well as the inquirer's, while the latter would be able to check the trouble. Inquirers should not be afraid of worrying the writer too much in describing complete details of the symptoms observed, the food supplied, and the conditions surrounding the stock.

Protection against marauding Vermin.

It is safe to say that if a close estimate could be arrived at of the chickens that are lost each year through the depredations of cats and rats, to say nothing of stoats and weasels, it would run into astounding figures. More particularly is this the case on farms and other places where the

chickens are hatched under a hen in unprotected corners. The failure to rear the desired number of chickens is usually put down to bad luck. It is more often a matter of bad management. The obvious policy is to only attempt to hatch the number of chickens that can be properly protected and reared. It will be found cheaper in the long-run to provide proper coops with runs attached for the mother hens and their broods.

The coops should be so made that they can be easily moved about on to fresh ground. They should also be rain and rat proof, while in addition the important matter of having the coops well ventilated must not be overlooked. The runs also should be made in such a way as to protect the chickens from their natural enemies. A common mistake is to make the run too small. It is not enough that the chickens should be able to stretch themselves. They should have sufficient room to take some exercise, for exercise, if not overdone, is essential to their development.

—F. C. Brown, Chief Poultry Instructor, Wellington.

THE APIARY.

Taking Surplus Honey.

WHERE the beekeeper has succeeded in getting his colonies into good order for the honey-flow there should be some honey for extracting by the end of the current month. If the stocks of surplus combs on hand are not sufficient to harvest the crop there is a danger that the immediate requirements of the bees may not be met. It is well, therefore, to look over the upper stories and note those which contain sealed honey. These can then be removed and extracted, and returned to the hives to be refilled.

In this early extracting great care must be exercised not to remove any combs but those which are fully sealed, as in the height of a honey-flow much unripe honey will be present in the hives, and this, if extracted, is likely to ferment. The practice of extracting from unsealed combs during a flow cannot be too strongly condemned, as it results in the production of honeys of poor flavour, coarse grain, and low specific gravity. All partly sealed combs should be left on the hives until after the flow, in order to get the honey in them well ripened.

Extracting during a flow has advantages, providing the above precautions are taken, as fewer combs are required and little or no robbing has to be contended with during the tedious process of removing honey from the hives. Where ample stocks of combs are on hand to meet the demands of a large flow the hives can be supered as required, when the work of dealing with the crop may be left until the end of the season. If this practice is followed the beekeeper will be assured of a well-ripened honey of good quality and high grade.

The Honey-house and its Requisites.

It may be well to remind beekeepers who have only a few colonies, and who make use of existing buildings for extracting, of the requirements of the regulations under the Sale of Food and Drugs Act. These provide that "every place used for or in connection with the sale, manufacture, preparation, storage, or packing of any food for sale shall be used for that purpose only; and no place shall be so used which is at any time used as a sleeping apartment, or in which any animal is allowed to be, or which is or has been used for any purpose which would be likely to contaminate such food or injuriously affect its wholesomeness or cleanliness."

These conditions make it obligatory on the part of the beekeeper to exercise scrupulous care and cleanliness in handling honey as an article of food. The first requisite is a bee-tight house, having wire cloth screens

fitted with escapes on the windows. These screens are necessary to allow bees which enter with the supers to escape, and to prevent the entry of robber bees which are attracted by the smell of the honey. Now that electric light is available to most beekeepers it will be found to be a distinct advantage to employ it for lighting the extracting-room. If this method is adopted the room is best divided into two compartments; the part containing the extractor, uncapping box, and supers of honey can be artificially lighted, thus allowing the bees to pass through the doorway to the window in the end of the storage-room. Thus the operator is not hindered by the flying bees, and the tanks do not require to be covered; moreover, any robber bees which may enter will be immediately attracted to the lighted window.

Extractors and their Care.

Extractors are made in different sizes—from two to eight frames. In the choice of an extractor a beekeeper will be guided by the number of colonies he is operating. For any number of colonies up to one hundred he will find a two- or four-frame reversible machine most convenient. For more than a hundred colonies it will pay to install a power machine.

A recent decision of the Health Department renders it possible now to use extractors made of galvanized iron without coating them with beeswax internally. The application of wax to the machines was considered necessary in the interests of health. However, this has been dispensed with on the strict understanding that the equipment is kept in scrupulously clean condition. Too often extractors are left without cleansing after the season's operations, and during the winter the acid in the honey attacks the metal, rendering it well nigh impossible to thoroughly cleanse the machines before they are again brought into use. Apart from this all trace of honey should be removed, as it is liable to ferment, and in the course of time the whole outfit becomes soured and permeated with destructive bacteria.

Honey-tanks.

For the preparation and care of the honey after extracting it is necessary to provide suitable tanks. These should be made of tinned steel and externally soldered, in conformance with the regulations under the Sale of Food and Drugs Act. It has been proved by experience of late years that deep round tanks are the most suitable. These tanks obviate to a great extent the disagreeable necessity of straining the honey, and help to eliminate both froth and scum, which otherwise render the honey unsightly when it rises to the surface.

Extracting.

To do the work expeditiously two people should be engaged—one to do the uncapping and the other to operate the extractor. In the process of uncapping, the comb is placed on the cross-bar on top of the uncapping can. The projecting screw point prevents the frame from slipping and acts as a pivot on which to revolve the combs. The comb should be placed with one end resting on the pivot and tilted slightly forward, in order to allow the cappings to fall away from the combs as they begin to peal off.

For removing the cappings what is known as the Bingham knife is usually first favourite. Provision must be made to keep the knife warm, and this can be accomplished by immersing it in hot water. The knife should have a keen edge and be thoroughly clean before starting operations. Uncapping should commence at the bottom, and the knife proceed with a forward and backward motion, the same as when using a saw. Make a practice of uncapping as wide a surface as possible, and endeavour to remove the entire surface of the comb without once removing the knife. A little experience will enable the operator to cut below the surface of the cappings, remembering the cleaner the cut the freer the honey will be of wax particles when extracted.

Dealing with the Cappings.

After the combs are uncapped the problem of dealing with the cappings must receive consideration. Where these are stored for an indefinite period the honey may granulate or take up moisture from the atmosphere and thus become a total loss. If the beekeeper does not possess one of the melters in general use he should improvise some means for straining them. A hive-body covered with coarse wire cloth at the bottom and placed in a tray with a lip provided at one end to drain off the honey will answer the purpose for small quantities of cappings. For dealing with large quantities it is well to install a good melter, but before doing so the beekeeper should satisfy himself that it will not impair the quality and colour of the honey.

Returning the Combs.

After the combs are extracted they should be placed on the hives in the evening. If this practice is followed the bees have a chance to clean them during the night, and robbing is not likely to follow. Nothing will excite the bees more than wet combs placed on the hives during the day; they promote wholesale robbing, and, moreover, the bees take advantage of the opportunity to enter the honey-house every time the door is opened.

—E. A. Earp, Senior Apiary Instructor, Wellington.

HORTICULTURE.

Vegetable Crops.

Among the important duties demanding attention at this season is the cultivation of crops of young plants recently set out and seedlings. Success or failure very largely depends on the proper performance of such routine work as this; much more than any "trade secrets" does it contribute to success.

If the seed is of a good strain the proper preparation of the land and suitable cultivation afterwards are most likely to ensure a good crop. To do this economically and effectively the land must be studied, its condition and behaviour must be understood and watched, and the insects and weeds in the ground known, so that their action may be anticipated. To such a study there is no finality, but it is most interesting, and as experience is gained judgment improves, and gradually good results are attained with comparative ease. If there is any "royal road" this is it.

Light cultivation through a young crop on a fine day—if it has not had that attention recently—will put a sheen on the foliage and increase its growth at once. This is caused by breaking up the surface crust and clods, aerating the soil, oxidizing the particles, liberating the mineral plant-foods, and conserving the moisture which, with the acids present, present these foods in the soluble form in which they can be absorbed by the plants. And not only does it do that, but the disturbance of cultivation destroys many insects and sprouting weed seeds that may injure or compete with the crop. It can only be harmful if done so deeply as to disturb the roots of the growing plants, or if done on heavy ground when it is in wet condition so that it forms a paste which tightens the surface instead of rendering it more open—a serious condition that takes a long time and much care to remedy. Hoe the young crops, then, in fine weather so soon as they are established or appear through the ground, and again about three or four weeks later.

Unless the seeding has been very nicely adjusted many crops must also be thinned out, chiefly the large root crops and silver beet; spinach, parsley,

radishes, peas, and beans are more easily sown at the required rate. Where thinning is needed it should be done so soon as the plants are large enough to handle easily, and when patience is acquired it is a light job that is not unpleasant; anyhow the fine even size of the resulting crop is a very encouraging reward and growth is more rapid when the plants have room to develop. The neglect of such simple attention is the cause of most of the poor results experienced, and an easy success is due to these attentions and the careful study of detail without being fussy.

To maintain a supply of salads during the winter continue sowing the necessary crops, including mild white onions such as Spanish or Tripoli, &c. Such quick-developing crops as spinach and turnips (a yellow-flesh variety is usually most suitable) may also be sown now; but most important are the crops of early cabbage and cauliflower, which should be sown in a good seed-bed now, so that plants may be ready for planting out on a piece of warm well-prepared land about two months later. As good preparation requires time as well as labour, set about it so soon as the land is released from other crops. The warmer portion of the plot set aside in the rotation for crops of the botanical natural order of Brassica (cabbage, cauliflower, &c., turnips, and mustard) during the coming season is most suitable.

Give necessary attention to the celery crop; to blanch it will take four to six weeks; a commencement may be made when the growth is three-quarters completed. The early crop may now have the preliminary attention; remove suckers and yellow leaves, tie together the stems of each plant lightly, and keep the crop well supplied with water and liquid fertilizers.

The Tomato and its Virtues.

The outside crop is now ripening, and packing and marketing the fruit keeps the grower busy. Where it receives attention this crop is produced in sufficient quantity for the present demand, but the price and demand could no doubt be increased with suitable seasonable advertising. It is perfectly obvious that the dental condition of many people and their lounging habits indicate a scorbutic condition due to a lack of vitamin C. Cereals and meats, and even eggs and milk, contain little or none of this vital element, and how many people live on them almost entirely. Vitamin C is found in most fruit and vegetables in varying quantities, but tomatoes are one of the few kinds which are a specially rich source of supply. Commercial growers of tomatoes would no doubt help the sale of the crop and increase the health and happiness of the people if a little seasonal co-operative advertising were done, especially if accompanied by a real effort to equalize and sustain the distribution of the supply.

Small Fruits.

Many small-fruit crops have been harvested for the season, but among those to come are Cape gooseberries, tree tomatoes, Chinese gooseberries, feijoa, passion-fruit, guavas, and loquats, extending the harvesting period right on until the spring, when the cycle of small-fruit harvests again commences. New plantings should be carefully considered, the suitability of the land, the climate and the demand for any particular kind, as well as a variety which will also suit these conditions, all require attention; no doubt in most districts quite a varied supply of these fruits could easily be maintained, which would be useful and of great interest.

In Northern districts the planting of strawberry crops takes place in the months of April and May, but in colder localities planting is best done earlier. Where the crop is grown only for one season or the area is small the spacing of the plants is rather more close—24 in. to 30 in. between the rows and 9 in. to 12 in. between the plants, according to the vigour of the variety. Where the areas are large, more permanent and horse implements

are to be used; 3 ft. between the rows is not too much. If the land is prepared as previously suggested, and is clean, smooth, and firm, good plants set out now, or as soon as available, should do very well in almost any part of this country where the soil is not too light and dry. A convenient method is to mark out the land and insert a narrow, clean, sharp spade where a plant is to be placed, pull it forward, set the plant in position, spreading the roots well, withdraw the spade, and firm the soil about the roots. A common mistake is to set the plants rather high, due probably to planting cultivated ground before it has settled down. Such a crop often suffers from want of water and the berries are small. Trouble is also commonly due to careless use of the hoe when cultivating after planting; an inch or so is quite deep enough, and if weeds have to be removed from the close vicinity of a strawberry plant carefully replace the soil so that the collar of the plant is not left exposed to dry out.

The Homestead Garden.

Spring-flowering bulbs are planted during the autumn until the month of April, but it is an advantage generally to put them in early. Planted now in rather large groups in a shrubbery or border, or in a lawn where the soil is rich and moist, they make a display in early spring and summer when other blooms are scarce. They also require but little attention, and often flower best if undisturbed for a number of years. Nothing perhaps affords such a good display for so little trouble.

Lilies also are choice plants that provide an unsurpassed display for some years with little attention, as they dislike interference when they are established in a suitable spot such as among dwarf shrubs. They are best planted, without allowing the bulbs and roots to become dry, soon after the flowers fade, in a rich moist soil with a covering of about 6 in. or 8 in., or, say, three times their greatest diameter.

Pæonies also prefer such conditions, and are best left to bloom undisturbed for a long period. They are perfectly hardy and may be obtained in considerable variety. With herbaceous phlox to extend the season of blossom, they make a good display even when partially shaded. The eyes should be set 2 in. below the surface; they are best planted in early autumn.

Hedges trimmed now retain a neat appearance for a long period. If the top is narrower than the base the latter will retain its foliage better, especially if long grass and weeds are suppressed. It is chiefly the lack of light about those parts that makes them bare and so spoils one of the finest features of a well-managed garden. If the hedge is young and has not reached its full height it will generally be best not to trim the top until winter or spring, or even in the case of some conifers until the ultimate height has been attained.

If the lawn has suffered from drought or is in poor condition it should be well raked and closely cut, then given a thin top-dressing containing a generous amount of nitrogen and insoluble phosphate, with a moderate amount of soluble phosphate and small percentage of potash. Follow this up shortly after with a generous sowing of suitable lawn-grass seeds.

At this season the discovery is often made that the brown chafer beetles have laid their eggs and infested the lawn with the troublesome grass-grub. This is done towards the end of the year, and early in the New Year the young larvæ soon make their unwelcome presence obvious to those who are vigilant. An improvement in the methods of control of this troublesome pest is being constantly sought, and the latest published reports of the entomologists of the Plant Research Station at Palmerston North are of great assistance. Experiments proved that an injection of carbon bisulphide was a superior remedy that was immediately effective but costly,

and an inch or so of grass round every hole was killed. For the treatment of grub-infected turf a remedy that is cheap and effective and without damage when properly applied is a coal by-product known as Restar. Of this there are several grades, but that only should be employed which is known as Restar grass grub exterminator; used at a strength of one part to one hundred and fifty parts of water by volume it should be applied to infected areas at the rate of 3 gallons to the square yard. Apply it slowly with a watering can and take care that it does not run or puddle; if necessary the turf should be loosened with a fork before treatment, but generally these attacks are on light absorbent lands. Follow up the application of the solution immediately with clean water, applying it at the same rate, 3 gallons to the square yard. If the treatment is applied so that walking over the treated area is avoided no puddling need take place.

—W. C. Hyde, Horticulturist, Wellington.

INVENTIONS OF AGRICULTURAL INTEREST.

APPLICATIONS for patents, published with abridged specifications in the *New Zealand Patent Office Journal* from 17th November to 15th December, 1932, include the following of agricultural interest:—

No. 67904: Dressing flax; J. Dudson. No. 67903: Animal-trap; W. Ure. No. 68277: Tightening-device for binding wires on boxes; Gerrard Wire Tying Machines Co., Pty., Ltd. No. 68636: Testing milk in cheesemaking; Wilkins Ltd. No. 68840: Milking-machine; Kia-ora Milking Machine Co., Ltd. No. 68257: Scrub-cutter; H. G. L. and M. I. L. Bischof.

Copies of full specifications and drawings in respect of any of the above may be obtained from the Commissioner of Patents, Wellington, price 1s. prepaid.

Russeting of Apples.—Russeting is reported to be prevalent this season in the Nelson district, especially on the Cox's Orange and Delicious varieties. This is considered to be probably due to the weather during October. Last year, when dry conditions prevailed during October and November, apples were practically free of russeting.

Frost Injury to Lemon-trees.—The Orchard Instructor, Hastings (Hawke's Bay), reports that in his district during last winter lemon-trees were cut back by frost more than for many years past. Although the cold was possibly more severe, the main factor was probably that owing to the good autumn rains experienced the trees put on a large amount of sappy growth which was not hardened off before the frosts set in—hence the damage.

Licensing of New Manufacturing Dairies.—Amending regulations under the Dairy Industry Act, gazetted on 17th November, 1932, and coming into force from that date, provide that no person shall carry on the manufacture of dairy-produce in any manufacturing dairy, other than those already in operation, except in pursuance of a license to be granted by the Director of the Dairy Division. In the event of the application being declined by the Director, the matter may be referred to a Committee consisting of three persons to be appointed by the Minister of Agriculture. This committee will, in particular, advise on the following matters in relation to the application: (1) The economic necessity for the establishment of a manufacturing dairy or an additional manufacturing dairy in the respective district; (2) the prospect of carrying on successfully the manufacture of dairy-produce in the premises sought to be licensed, having regard to all relevant circumstances; (3) the probable effect of competition from the manufacturing dairy sought to be licensed on the quality of dairy-produce which might be manufactured therein or in competing manufacturing dairies.

WEATHER RECORDS: DECEMBER AND CALENDAR YEAR, 1932.

Dominion Meteorological Office.

NOTES FOR DECEMBER.

THE first half of the month was, for the most part, cool and rather stormy, in marked contrast with the second half, during which warm and muggy, but relatively quiet, weather prevailed.

Rainfall.—The Auckland and Coromandel Peninsulas had approximately the normal rainfall for December, but the remainder of the North Island only about half of it. Nelson and Marlborough experienced a similar shortage. In western districts of the South Island and most of Otago the distribution was irregular, the variations from average generally being small, with those on the side of low rainfall predominating. In South Canterbury and about Oamaru the average was considerably exceeded.

Temperature.—Temperatures were, on the whole, rather below normal, more especially in eastern districts. The departures were, however, seldom large, and parts of western districts and the higher country had rather warmer weather than usual.

Sunshine.—The amount of sunshine was generally about average. Napier, with 267·4 hours, had the most, while Tauranga followed with 254·5 hours.

Pressure Systems.—The month began with cold southerly winds, following the passage of a depression at the end of November. On the 3rd a fresh but rather shallow depression crossed the Dominion from west to east. Although southerly gales followed it in some places on the 5th, this disturbance produced only scattered rains. It was of interest, however, because from the 5th to the 7th when the general direction of the wind was south-west, north-easterlies frequently blew in parts of Canterbury and North Otago. The weather was very humid, and numbers of thunderstorms, with heavy downpours and some hail, occurred in the districts concerned.

Between the 8th and 10th a rather deep cyclonic depression, followed by a slight secondary, crossed northern Otago. Northerly gales blew in Cook Strait as it approached, while a southerly gale in rear of the centre caused some damage at Greymouth on the 9th. Christchurch and Banks Peninsula experienced a southerly gale on the 11th. This storm caused the most general rains in the month, and many of the falls were heavy. In Southland there was some flooding on the 10th.

Another shallow depression passed rapidly on the 14th, and was followed by a fairly intense anticyclone. This moved to the east of the Dominion on the 16th, and pressure remained high there almost to the end of the month. During this period very sultry, cloudy, and muggy weather prevailed, pressure being low and conditions rather disturbed in tropical regions from Northern Australia to the Cook Islands. Depressions, which had been deep and vigorous in Australia, lost energy as they approached New Zealand. Had the warm, moist air then covering the New Zealand area been invaded by a strong current of cold air from the south, general and heavy rains would have occurred, but these were conspicuous by their absence. Though rain occurred on most days, the amounts were very irregular and many places received very little.

Shallow depressions passed on the 19th, 22nd, 26th, and 30th. The period from the 22nd to the 26th was particularly warm and humid, and although a southerly change on the 27th lowered temperatures the weather still remained muggy.

Wellington, 6th January, 1933.

RAINFALL FOR DECEMBER AND CALENDAR YEAR, 1932, AT REPRESENTATIVE STATIONS.

Station.	December, 1932.				Calendar Year.	
	Total Fall.	Number of Wet Days.	Maximum Fall.	Average December Rainfall.	Total Rainfall in 1932.	Average Yearly Rainfall.
	North Island.					
	Inches.		Inches.	Inches.	Inches.	Inches.
Kaitaia	2·93	13	1·66	2·61	38·27	55·37
Russell	1·93	11	0·64	2·60	50·79	49·89
Whangarei	3·09	13	1·13	2·98	49·48	61·02
Auckland	2·97	11	0·94	2·91	40·48	44·89
Hamilton	1·94	11	0·51	3·55	33·16	50·21
Rotorua	2·33	10	0·90	3·76	40·01	55·18
Kawhia	2·40	12	0·55	3·34	41·94	54·17
New Plymouth ..	1·84	10	0·81	4·28	46·15	60·04
Riversdale, Inglewood	3·01	9	1·55	7·57	76·23	104·75
Whangamomona ..	3·43	6	1·71	5·72	58·20	78·27
Eltham	2·10	8	1·03	3·93	51·73	55·73
Tairua	5·04	9	2·30	4·34	63·66	64·49
Tauranga	1·99	8	0·70	3·62	45·04	53·01
Maraehako, Opotiki ..	3·10	12	0·86	2·91	43·52	53·74
Gisborne	1·71	6	0·49	2·31	41·44	45·21
Taupo	1·44	10	0·56	3·17	32·66	44·31
Napier	0·68	9	0·18	2·31	27·72	35·45
Hastings	0·83	8	0·35	1·93	26·50	32·11
Taihape	1·68	13	0·32	3·30	24·87	37·38
Masterton	1·84	11	0·53	2·89	32·60	38·73
Patea	1·62	5	0·63	3·59	35·73	45·12
Wanganui	2·03	9	0·83	2·70	27·18	36·29
Foxton	2·17	8	1·10	2·67	25·04	32·85
Wellington	2·60	9	1·14	2·84	38·87	41·08
	South Island.					
Westport	6·84	13	2·31	8·45	84·38	96·80
Greymouth	7·26	12	1·58	8·72	80·15	101·19
Hokitika	10·75	15	2·22	10·44	105·72	115·42
Ross	13·36	15	2·59	11·99	118·33	136·25
Arthur's Pass ..	10·41	12	3·30	14·34	118·75	162·50
Okuru	7·21	6	3·56	11·14	111·12	145·96
Collingwood	4·08	8	1·04	8·21	69·02	97·40
Nelson	1·77	13	0·67	2·98	30·30	37·64
Spring Creek ..	1·10	10	0·90	2·14	25·21	30·50
Hanmer Springs ..	2·44	10	0·77	3·94	37·13	45·57
Highfield, Waiau ..	1·29	8	0·30	2·67	28·30	33·70
Gore Bay	1·14	10	0·53	2·66	29·17	31·40
Christchurch	2·09	12	0·56	2·15	21·09	24·99
Timaru	2·78	12	0·65	2·43	26·08	22·56
Lambrook, Fairlie ..	3·65	10	0·91	2·54	25·60	24·87
Benmore, Clearburn ..	3·32	13	1·10	2·31	21·53	25·05
Oamaru	3·00	12	0·73	2·24	24·31	21·97
Queenstown	2·32	11	0·95	2·53	22·31	30·63
Clyde	0·77	8	0·22	1·79	13·26	15·26
Dunedin	2·06	14	0·40	3·54	32·23	36·84
Wendon	3·33	13	0·66	2·78	30·19	29·92
Gore	3·22	..	..	3·29	..	34·34
Invercargill	3·53	15	0·71	4·07	42·68	45·85
Puysegur Point ..	7·72	17	2·10	7·14	71·34	86·03
Half-moon Bay ..	2·94	12	0·84	5·01	48·38	59·40

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

THE EARWIG PEST.

"PERPLEXED," Cardrona :—

Can you advise me of a satisfactory method of getting rid of earwigs in the garden—by poisoning or otherwise? They are getting so bad here that it is impossible to grow vegetables; carrot-tops are being eaten off and cabbage riddled right into the centre. How did the earwig get introduced into this country? Is it correct that it was introduced to control the codlin-moth, but proved a failure?

The Horticulture Division :—

The earwig is now found in most parts of the Dominion, but nowhere probably does it do so much damage to crops as in the drier parts of Otago. Needless to say, such a well-known pest was not introduced intentionally, as it has no merits as a parasite. Experiments for the control of this pest, which is so destructive of vegetables, fruits, and flowers, have been carried out in Otago by the Department of Agriculture for a number of years. The most effective method tried up to the present is a bait composed of bran 6 lb., sodium fluoride 6 oz., treacle 2 lb., glycerine 2½ oz., water 3 quarts. Dissolve the sodium fluoride in the water, add the treacle, and mix with the bran, then add the glycerine. Towards the evening spread the bait in small heaps about the garden, renewing the application after rains or when the bait becomes dry.

CRESTED WHEAT-GRASS.

H. L. BARKER, Ashburton :—

Will you kindly advise regarding the suitability of crested wheat-grass for sheep grazing on light land? During the past year small trial plots have been established in the hill country of the Ashburton County with encouraging results.

The Fields Division :—

Crested wheat-grass is a Canadian species. It is claimed to be highly palatable and of high feeding value and comes away earlier in spring than any other grass in the west of Canada. Moreover, it is stated to be much stronger rooted than rye-grass, and this latter characteristic is regarded as of paramount importance in the prevention of soil-drifting, a problem much to the fore in western Canada. Comparatively little is known of this grass in New Zealand, and at present we are unable to indicate how it would behave on light land under Canterbury conditions. Endeavour will be made, however, to have the small trial plots you mention inspected as opportunity offers.

BUTTERCUPS IN PASTURE.

"SUBSCRIBER," Birkenhead :—

Can you advise me of a satisfactory method of getting rid of buttercups from our paddocks? Most of the paddocks in this district seem to be infested with them this year. Is there any reason, in your opinion, for this?

The Fields Division :—

The only practical method so far known for keeping buttercups in check is to mow or scythe them. This will check them considerably, and prevent smothering of the pasture and diminish the seeding of the buttercups. Two mowings may be necessary where infestation is bad. The use of super to force the growth of grass after cutting is of help in making competition for the buttercups more severe. Buttercup infestation has certainly been more apparent this year; the seasonal weather must have been extremely suitable.